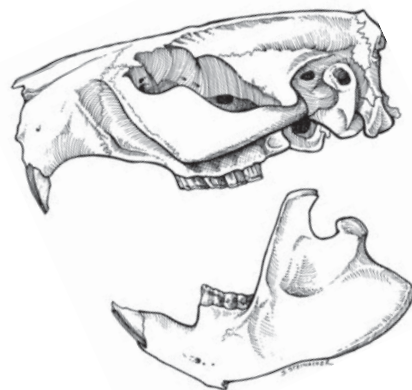
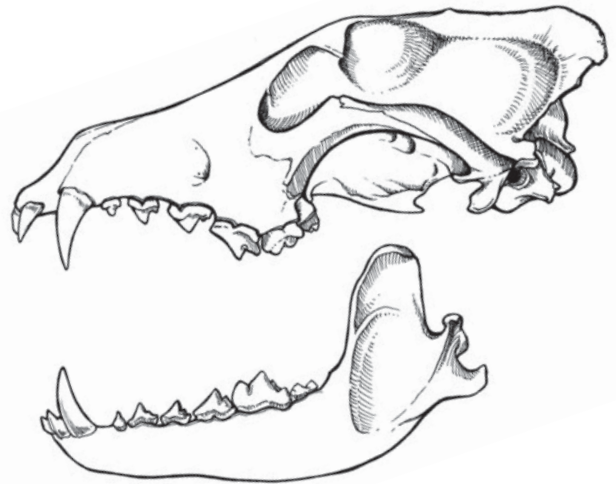
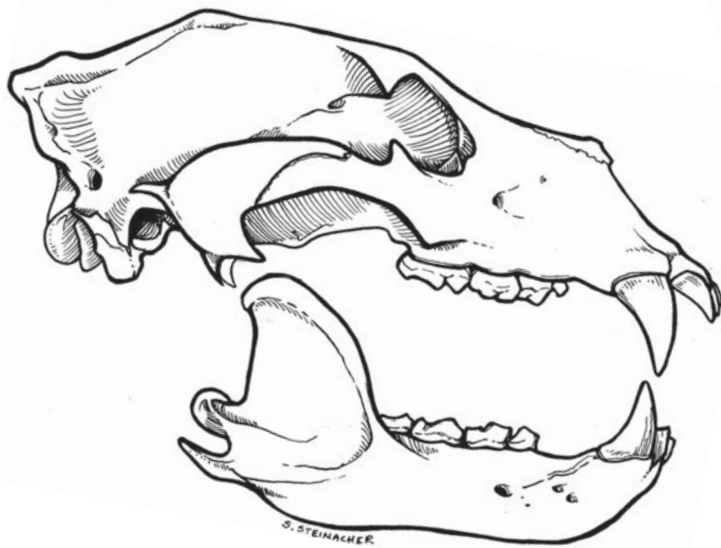


Skulls of Alaskan Mammals

A Teacher's Guide



Alaska Department of Fish and Game
Division of Wildlife Conservation
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Skulls of Alaskan Mammals

A Teacher's Guide

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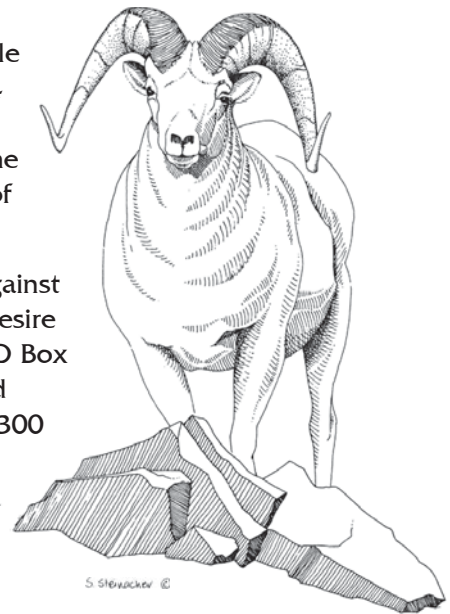


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1. Introduction

Skulls as teaching tools

Animal skulls are a great tool for teaching about the diversity of Alaska's wildlife and the special role each animal plays in its natural environment. This guide provides background information on skulls for educators, and hands-on activities for students.

This guide accompanies skulls available from the Alaska Department of Fish and Game for loan to educators. Together they will help you introduce students to skull identification, the form and function of skulls, the design of dichotomous keys, and techniques for illustrating skulls. The lessons are written for upper elementary through high school students. All lessons are correlated to the Alaska state content standards. The guide and skulls are also available on loan through Alaska Resource Library and Information Services (ARLIS).

Handle with care

The skulls have been generously provided by hunters and trappers for educational purposes. Please remember that the skulls should be handled carefully. It is especially important to keep fingers out of the nose holes (turbinades). The smaller skulls, particularly hare and weasel, are very fragile.

Students should be sitting down when handling skulls, using both hands to pass them, preferably over carpeted floor. Please return loose teeth and any broken pieces so they can be repaired for others to enjoy.

Enjoy!

We hope you and your students enjoy learning about skulls of Alaskan mammals. If you have any suggestions for improving the teacher's guide, please contact us!

Discover many more teaching resources about wildlife at:
www.wildlife.alaska.gov



2. About Skulls

When investigating skulls more closely, it becomes clear how skulls are used for mammal classification. Many interesting and unusual relationships between animals are revealed by their skulls. Skulls also give clues about how the animal is adapted for survival in its environment and indicate how these adaptations may have led to the evolution of different species.

Teeth

Teeth tell us whether an animal is a **carnivore** (meat eater), **herbivore** (plant eater) or **omnivore** (both meat and plant eater). Some interesting features for each of these groups include:

Carnivore teeth

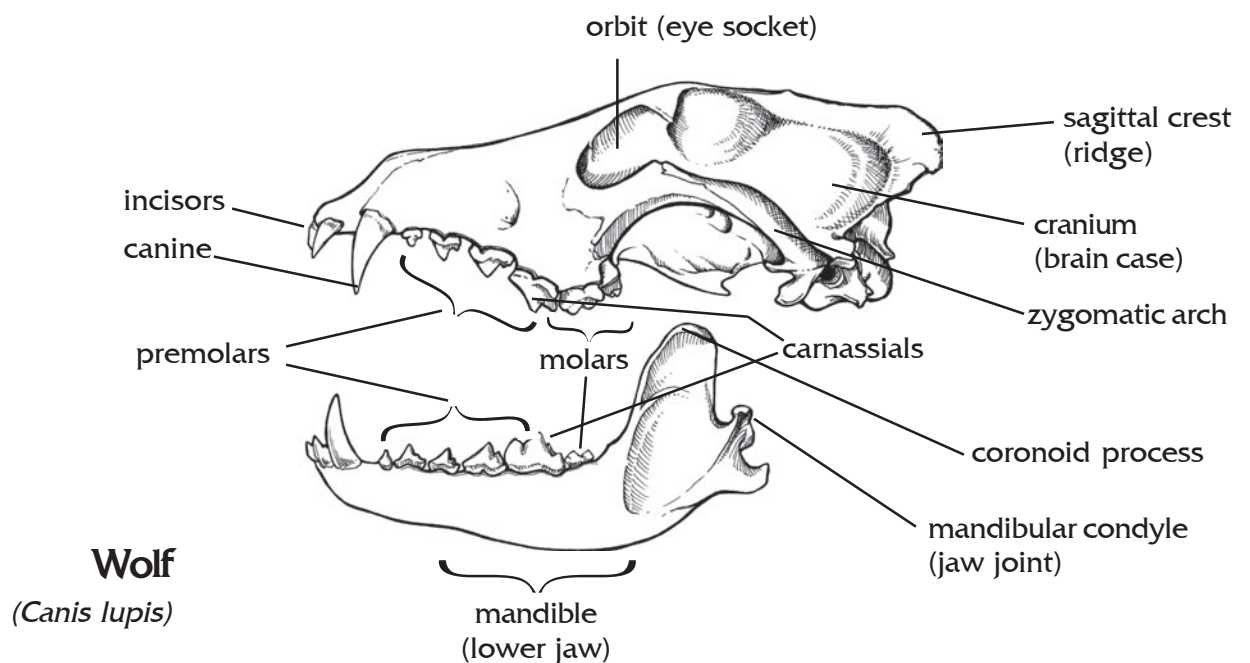
Carnivore teeth are specialized for tearing and shearing. They have three primary types of teeth for three different functions.

The **incisors** (front teeth) are relatively small and less developed than the canines and are used for grooming and fine nipping of tender foods.

The **canines** (cuspids or eye teeth) are sharp and long for piercing and holding prey.

The **cheek teeth** (premolars and molars) are sharp for tearing and cutting. Cheek teeth exhibit the greatest amount of specialization, indicating what the animal eats.

In carnivores, some of the upper premolars overlap with the lower teeth, and are known as the **canassial teeth**. Canassials act like shearing scissors.



Cats (family Felidae), such as the lynx, have the sharpest **caninials** that are specialized entirely for shearing meat. Canids (family Canidae), such as dogs, wolves and coyotes, have **caninials** with crushing as well as shredding surfaces allowing for a more varied diet. These specialized molars allow carnivores to break bones and eat the rich marrow inside.

mandibular condyle
(jaw joint)

The **mandibular condyle** is a process on the **mandible** (lower jaw) that fits into a groove in the skull to form the jaw joint. When an animal with a tight fitting **mandibular condyle** bites down, its **caninials** overlap tightly, and there is little side to side movement for chewing. The most extreme examples of this are seen in weasels (family Mustelidae) where the fit is so tight there is no side to side motion of the mandible.

anatomy of the bite

The **temporal muscles** (cheek muscles) give carnivores a forceful bite for eating meat. These muscles run from the **coronoid process** on the **mandible** (lower jaw) to the **sagittal crest** (ridge) on the **cranium** (braincase). A large cranium, the presence of a sagittal crest and a large coronoid process are characteristics of a skull specialized for a carnivorous diet.

Herbivore teeth

Some herbivores, such as **rodents and hares/rabbits**, don't have canines. Other herbivores, such as the **hoofed animals**, have canines that are not distinguishable from the incisors.

diastema

In all herbivores the incisors are well developed to cut vegetation. There is a wide space called a **diastema** between the incisors and the cheek teeth. This gap allows for food items to be easily carried or manipulated. In some rodents, such as beavers and hares, the lips close across the diastema, allowing the animals to gnaw with their incisors while keeping dirt, wood chips or water out of the mouth.

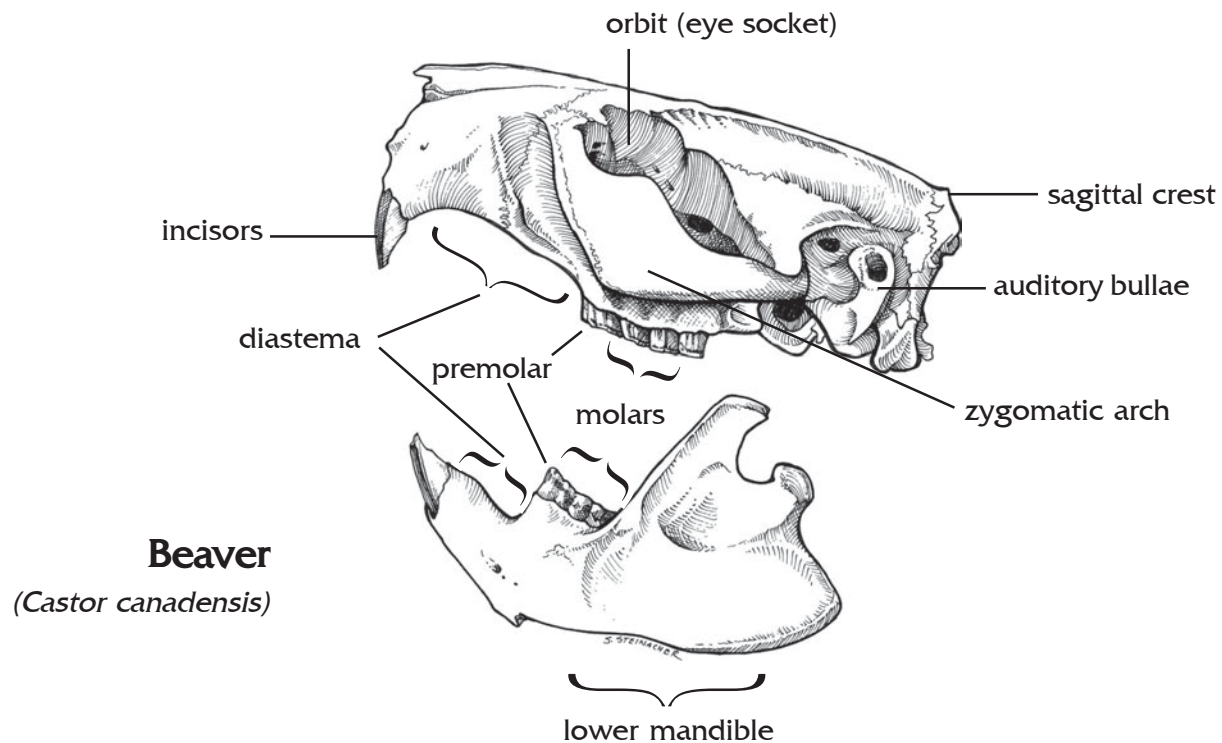
ruminants
(deer, moose,
caribou, elk)

Ruminants (cud chewers) are animals with several chambers in their stomachs that chew, regurgitate, and re-chew their food, such as deer and moose. Most ruminants do not have upper incisors or canines. Instead, they have a hard palate that the lower teeth press against to nip plants, which they can gather and hold in the diastema (space) between their lower incisors and cheek teeth. This allows ruminants to quickly gather and eat large quantities of food before retreating to protective cover to chew their cud for better digestion.

An interesting feature of the **hoofed animals** involves the canines. In the deer family (Cervidae) there is an inverse relationship between the size of the antlers and the presence of an upper canine. Moose have the largest antlers, but lack any canines. Caribou have smaller antlers but the canine is present though small.

**rodents &
hares/rabbits**
(beaver, muskrat, hares,
rabbits, mice, voles)

Rodents and hares/rabbits have chisel-like incisors to gnaw and clip vegetation. These teeth are subject to tremendous wear and their growth is continuous. If they did not grow continuously, the animals would eventually wear them down and be unable to eat. The opposite is also true; if the teeth are underused they grow beyond the lower jaw.



Beaver
(*Castor canadensis*)

rodents **Rodents** differ from **hares/rabbits** in that they have an orange enamel on the front of their incisors, which is backed by a softer white material (dentine) on the back of the teeth. As the teeth are worn, the harder enamel persists while the softer material wears, acting like self-sharpening knives.

hares & rabbits **Hares and rabbits** have a unique characteristic. Against the back side of their incisors, there is another set of smaller teeth called **peg teeth**. When they bite down, the lower incisors match up with the peg teeth making a clean, sharp cut.

In **herbivores**, the point where the jaw joins the skull is usually higher than the row of cheek teeth. This allows for side to side movement (chewing). This movement is driven by their **masseter muscles** (cheek muscles) rather than the temporal muscles used by carnivores. The masseter muscles are attached to the **zygomatic arch**.

Omnivore teeth **Omnivores** have both carnivore and herbivore teeth. They have well developed **incisors** for biting and cutting. The **canine** teeth are long and relatively sharp for piercing and holding prey. The **Cheek teeth** (molars and premolars) are a combination of sharp, scissor-like teeth for tearing meat and flattened molars with rounded cusps for grinding.

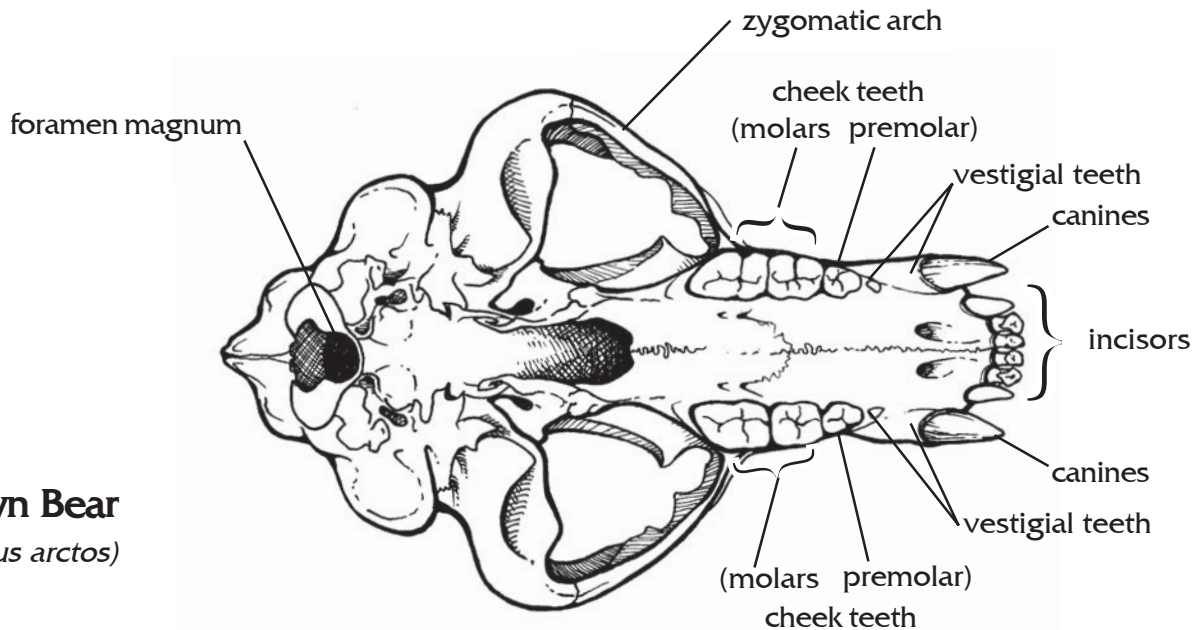
a tight jaw joint Omnivores generally have less side-to-side movement in the jaw for chewing than herbivores. The teeth are used more for shearing and crushing both meat and plants. However, some primates - including humans - are able

to chew food. The jaw joint is looser than other omnivores, and the teeth slide over one another, grinding the food. The high position of the jaw-joint increases the leverage of the **masseter muscles**. You can feel the masseter muscles at work by touching your cheek while chewing.

comparison of omnivore cheek teeth

The **cheek teeth** (molars) of omnivores indicate whether the species is predominantly a meat eater or predominately a plant eater. For example, black bears are omnivores that predominantly eat plants, and have cheek teeth that are flatter and wider for grinding plant material - more like an herbivore's. However, coyotes are omnivores that predominantly eat meat, and have cheek teeth with more pointed surfaces for tearing - more like a carnivore's.

Brown Bear (*Ursus arctos*)



Dental Formulas

The dental formula is the standard form for recording the number and type of different teeth a species has. The number and type of teeth are often major clues when identifying the skulls of similar species.

The dental formula of the marten is:

$$I \frac{3}{3}, C \frac{1}{1}, P \frac{4}{4}, M \frac{2}{3} = 42$$

I = incisor	3 on upper left side 3 on lower left side	P = premolar	4 on upper left side 4 on lower left side
C = canine	1 on upper left side 1 on lower left side	M = molar	2 on upper left side 3 on lower left side

The **left side** of the formula represents the number of teeth, upper and lower, **on one side of the jaw**. The **right side** of the formula is the **total number of teeth** in the skull. This is double the total of teeth on the left side of the formula since it includes **both sides** of the upper and lower jaw.

Eyes

The size of an animal's **orbits** (eye sockets) corresponds to the sharpness of their eyesight. Larger orbits indicate better eyesight. The lynx's most acute sense is vision and, proportionately, it has the largest orbit of all the Alaska land mammals. Most nocturnal animals, such as cats, have large eyes for nighttime vision, and therefore also have large orbits.

placement of orbits

The placement of the orbits on the skull give clues about whether the skull belongs to a **predator** or **prey**. (Predators eat other animals and prey are eaten by other animals.)

predator orbits

Carnivores orbits face forward on the skull, giving them **binocular vision** (see with both eyes). Forward facing eyes give carnivores **depth perception**; the ability to judge distance. This is critical to their ability to catch prey.

prey orbits

Herbivores have orbits located on the sides of the skull, so that they can see predators coming from all directions. Herbivores have **monocular vision** (see with only one eye.) Each eye can see approximately 180 degrees. For some herbivores, such as deer and moose, the orbits are angled slightly forward to give these animals **partial binocular vision**.

aquatic animal orbits

Eyes and nostrils on top of the skull are usually seen in animals that spend a good deal of time in an aquatic environment, such as the beaver.

Nasal Passages

The size of the nasal passage on a skull is related to the animal's sense of smell. The fragile bones inside the nasal passage, called **turbinal bones** increase the surface area for the olfactory membranes. Dogs (family Canidae) have a long nose with turbinal bones that are large and complex, indicating the family's highly developed sense of smell. The short nasal passages of cat skulls are indicative of a poor sense of smell. Cats obviously rely more on vision, as indicated by the large size of their orbits (eye sockets).

Auditory Bullae

The **auditory bullae** are the bulbous protrusions that encase the inner ear. Large auditory bullae indicate an acute sense of hearing. Cats have particularly large auditory bullae and an excellent sense of hearing. Marine mammals, like seal and sea lions, also have especially large auditory bullae and finely tuned hearing.

A beaver's **auditory bullae** are located comparatively higher on the skull than other rodents. This provides a clue about the aquatic environment it lives, the ears remain above the surface of the water to be able to hear predators or other dangers nearby.

Foramina

Foramina are holes within skulls for nerves and blood vessels to pass through. Large foramina indicate increased circulation to specific tissues. The largest foramen on skulls is the **foramen magnum**, the passage for the spinal cord to enter the **cranium** (brain case).

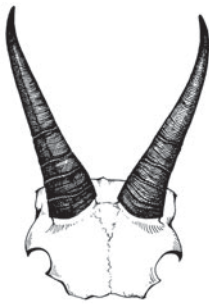
Foramina provide clues for identifying certain species. For example, you can tell the difference between a porcupine and a beaver skull by looking at the foramen below the orbits (eye sockets). The porcupine has a comparatively smaller skull but much larger foramina below the orbits than its relative, the beaver.

Plates

Skulls are divided into many plates. Each plate is considered a bone and is individually named. When an animal is young, there are obvious suture lines where the plates are divided. The plates are not joined completely to allow the head to grow along each of these lines. As an animal grows and matures, the plates eventually fuse (join together.) You can tell whether an animal is an adult or juvenile by looking at the suture lines to see whether or not the plates have become fused.

Horns

A horn is a slow growing, permanent bone. Horns are seen in the **cattle family** (Bovidae), which in Alaska includes **bison, Dall sheep, mountain goats and muskoxen**. Both males and females of these species have horns, although the males' are generally larger.



The center of the horn is a spike of bone that is fused with the skull. A hollow outer cone of true horn substance sheaths this bony core. Neither the bone core nor the outer sheath is ever shed.

Horns are not shed annually but are permanent throughout the life of the animal. Horns grow from the base, and an annual ring will show on the outer sheath for each year of growth. Annual rings can be counted and used for determining age.

Antlers

Antlers are also made of bone growing out of the skull, but are faster growing and temporary. Antlers are found in the **deer family** (Cervidae), which in Alaska includes **moose, Sitka black-tailed deer, caribou, reindeer and elk**. Generally only males have antlers, except for caribou, where females also carry antlers, although smaller than the males'.

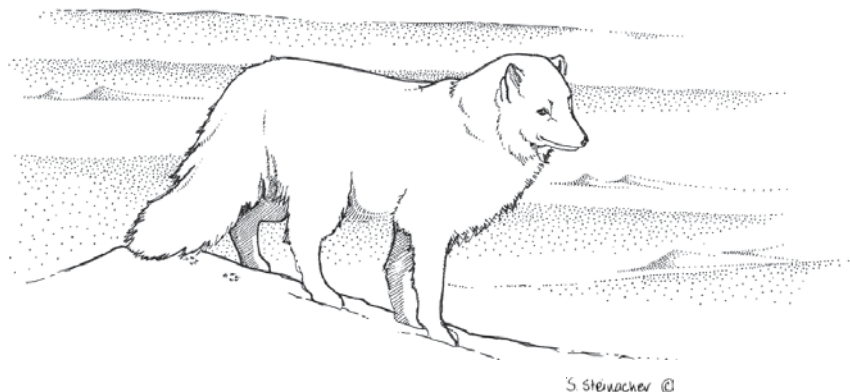


Antlers are shed annually (deciduous), usually in late winter, and begin growing again shortly thereafter. During growth, antlers are covered by furry 'velvet,' which is a layer of skin and soft, short hair. During the rutting season, the velvet dries up, and the animal scrapes or rubs it off. Later a ring of cells breaks down the bone at the base of the antlers, and the antlers fall away from the skull.

Antler growth depends a great deal upon the animal's health. The number of antler points does not indicate a deer's age.

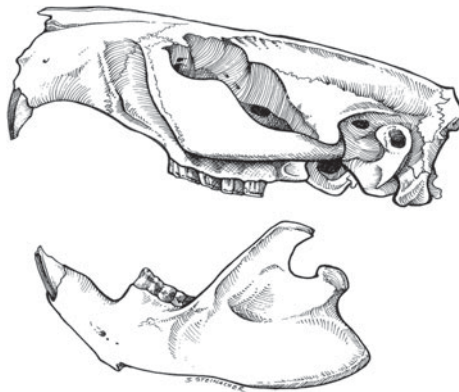
3. Activities

- A. Skull Detective: Teeth, Eyes & More
- B. Who's Related to Whom?
- C. Drawing Skulls
- D. Dichotomous Keys



A. Skull Detective:

Teeth, Eyes & More



Objectives

The learner will be able to:

- Make observations about dentition using food samples.
- Describe how an animal's teeth can tell us what the animal eats.
- Identify animals as herbivores, carnivores, or omnivores by looking closely at skulls.
- Describe how eye position indicates whether an animal is a predator or prey.
- Identify additional skull features: muscle attachment, nasal cavity, auditory bullae

Methods

Using demonstrations to illustrate types of teeth and the placement of the eyes, students will learn that there are many things they can tell about an animal by looking carefully at its skull.

Background

Refer to 'About Skulls' section.

Materials

- Skull collection
- Food samples (carrots, granola or popcorn, beef jerky)
- Fist-sized ball
- Skulls worksheet copied from guide (1/student)
- Skulls worksheet transparency (to be created by teacher using skulls worksheet)

Skull Detective

Grade Levels: Grades 3 - 6

Duration: 1 hour or two
30- minute sessions

Science Standards: A1 and C2

Skills: observing, inferring,
classifying

Vocabulary: canines, carnivore,
cranium, herbivore, incisors,
molars, omnivore, predator, prey

Procedures

1. Introductory questions

What is your favorite animal? (List these on the board and circle the mammals.)

What do the animals that are circled have in common? (Four limbs, hair, live young, warm blooded, mammary glands.)

Do any of these mammals live here in _____?

Explain to students that they will be learning about the animals living in their region by taking a look at their own skulls. ***Since we are mammals, let's start with us. We are going to be having a snack and see what we can learn about mammal teeth in the process. We will also have student volunteers help us to learn about how the eye location tells us something about what the animal eats/or is eaten by.***

2. You are what you eat

Before passing out samples of beef jerky, granola or popcorn and carrots to each student, explain that they will be making observations about which teeth are used to bite and chew each type of food.

- Ask the students to identify their own teeth. (incisors, canines, premolars and molars.)
- Ask the students to pay attention to which teeth they use to bite and then chew each food type.

- Also have them observe how their jaws move (up/down or side-to-side).

Student observations

There will be some variation, but in general students observe the following:

- When eating a **carrot**, it is easiest to use **incisors** to bite it in half. (Baby carrots work best for this activity. When the carrots are too large, students will use their molars instead.)
- When eating the **jerky**, we use **canines** to tear the jerky in pieces. (Stringy, tough jerky works best for this activity. Students will tear the jerky with canines, rather than nip it in half with incisors.)
- The **granola/popcorn** is chewed using the **molars**. Students will see that the jaw moves side-to-side rather than in an up-down motion. A loose attachment of the upper/lower jaw allows for side-to-side movement (chewing motion) for grinding up food.

Teeth as tools

Teeth are like tools, designed to do specific tasks. Incisors are used for nipping, chiseling and grooming. Canines are used for holding and tearing meat.

What are animals called who eat only plants? (Herbivores) *Only animals?* (Carnivores) *Both plants and animals?* (Omnivores) Emphasize the three types of animals by using colored pieces of chalk and circling the animals on the board the students named at the beginning of the lesson. Use green for herbivores, red for carnivores, and blue for omnivores.

3. Wolf & Moose game: The eyes have it!

Peripheral vision: Ask for three volunteers. Two students stand back-to-back. They will become a moose, with an eye placed on either of the head. To represent this, have the pair each close one eye. The third volunteer will act as a wolf, with both eyes facing forward.

Explain to the students you will be walking around the classroom in a circle and asking both the wolf and the moose whether they are able to see you from every direction. It is important to clarify that **the moose and wolf should not turn their heads to see you.**

As you walk around the room slowly, ask the moose, ***Do you see me, Moose? Then, Do you see me, Wolf?***

Continue to ask several times as you make your way around the room. You may also kneel down to change vantage point as well. When standing behind the wolf, he/she will not be able to see you, while the moose will be able to see you from all directions.

Ask the students, ***Why was the moose able to see me from all directions?*** (Its eyes are placed on either side of its head, giving it better peripheral vision than the wolf.)

Binocular vision: Have the moose volunteers return to their seats, and ask the wolf to stand several feet away from you. Throw a small ball to him/her. The wolf catches the ball. Then, ask the wolf to close one eye. Throw the ball again. This time, the wolf might not catch it. Ask, ***Was it easier to catch the ball with both eyes open?*** (Yes) ***Why?*** When both eyes are facing forward, it allows an animal to focus on an object with both eyes. This is called **binocular vision** and provides depth



S. Steinacher ©



perception.

Ask the students, *Why does an animal such as a wolf has binocular vision, while an animal such as a moose has greater peripheral vision?* A wolf is a predator and it catches its food. A **predator** needs to be able to determine how far away its prey is before it can lunge/leap to catch it. A **prey** animal, such as a moose, is eaten by predators and relies partially on its ability to see danger when it is coming. Being able to see almost 360 degrees gives a prey animal a chance to escape from its predators.

4. Skull exploration

Before passing out skulls explain that skulls are extremely fragile. They should stay at their table groups and pass skulls carefully from one person to another. Pass out skulls that include examples of all three groups (herbivores, carnivores, omnivores). Students may work with a partner or in small table groups to make observations.

Instruct students to look at the teeth and eye placement of several skulls. It is important to tell students that they do not need to identify the skull; observations about the individual skulls are much more important than simply putting a name to them. Students will be identifying skulls during another session.

Guide with questions

Is your animal an herbivore, carnivore or omnivore?

Herbivores: lack canine teeth. **Carnivores:** canines present, molars are also sharp with shearing teeth upper/lower jaw (carnassial). **Omnivores:** canines present, molars have wider,

Do the incisors look similar on all of the herbivore skulls?

Rodent skulls have orange enamel on the incisors, which is harder than the posterior portion of the tooth composed of dentine. As a result, the incisors are self-sharpening. Rodent teeth also grow throughout their lives. Think about what beavers eat. Sharp incisors are certainly important for eating wood. It is also important that the teeth continue to grow as they are worn down.

Deer and moose skulls lack upper incisors. They rely on the bony upper-palette and lower incisors to cut vegetation and strip leaves from branches. The lack of upper incisors allows ungulates (hoofed mammals) to take in more vegetation quickly before retreating to a more protected spot to chew their cud.

Why are the canine teeth on a carnivore so long? (For piercing and holding its prey.)

Can you tell whether this skull is from a predator by looking at the orbits? How? (The orbits are facing forward for binocular vision.)

Is this a predator that hunts at night? How can you tell? (Nocturnal animals have large eyes and large orbits.)

5. Wrap-Up

Ask students to share something they learned about mammals and/or skulls today. If time permits complete the skulls worksheet using an overhead while students fill in the diagrams on their own sheet. This worksheet can also be completed at the beginning of your next session with skulls, providing a quick review for the students.

Additional thoughts for students to chew on

Here are some questions to help guide students to observe other skull features and describe their functions.

Is this a male or female deer skull?

The male deer has antlers and female deer do not have antlers. Antlers are shed each year, but the point of attachment is still visible on the skull.

Does this animal have strong jaw muscles for tearing meat?

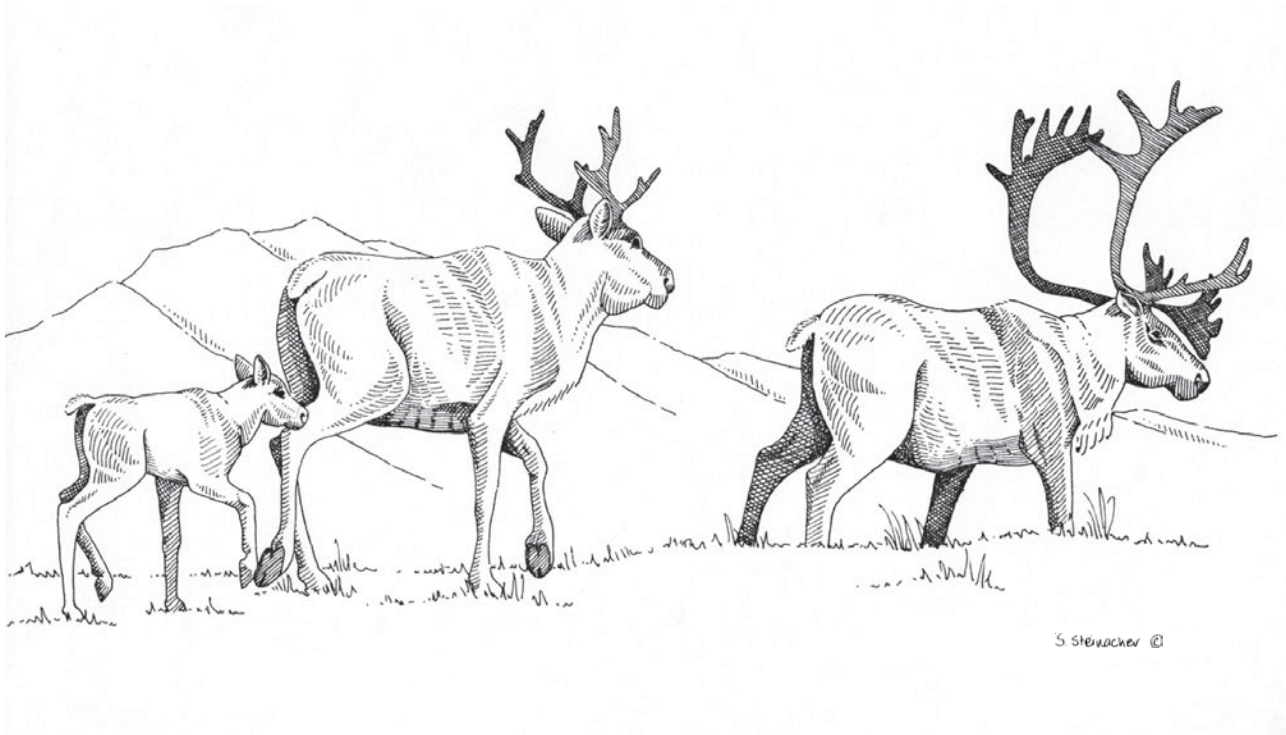
The weasel family (mustelidae) is known for its biting strength. The skulls show a pronounced sagittal crest where the muscles attach. The upper and lower jaws come together in a very tight fit. This eliminates the side-to-side motion of the jaw, giving more power for biting down.

Does this animal have a good sense of hearing?
How can you tell?

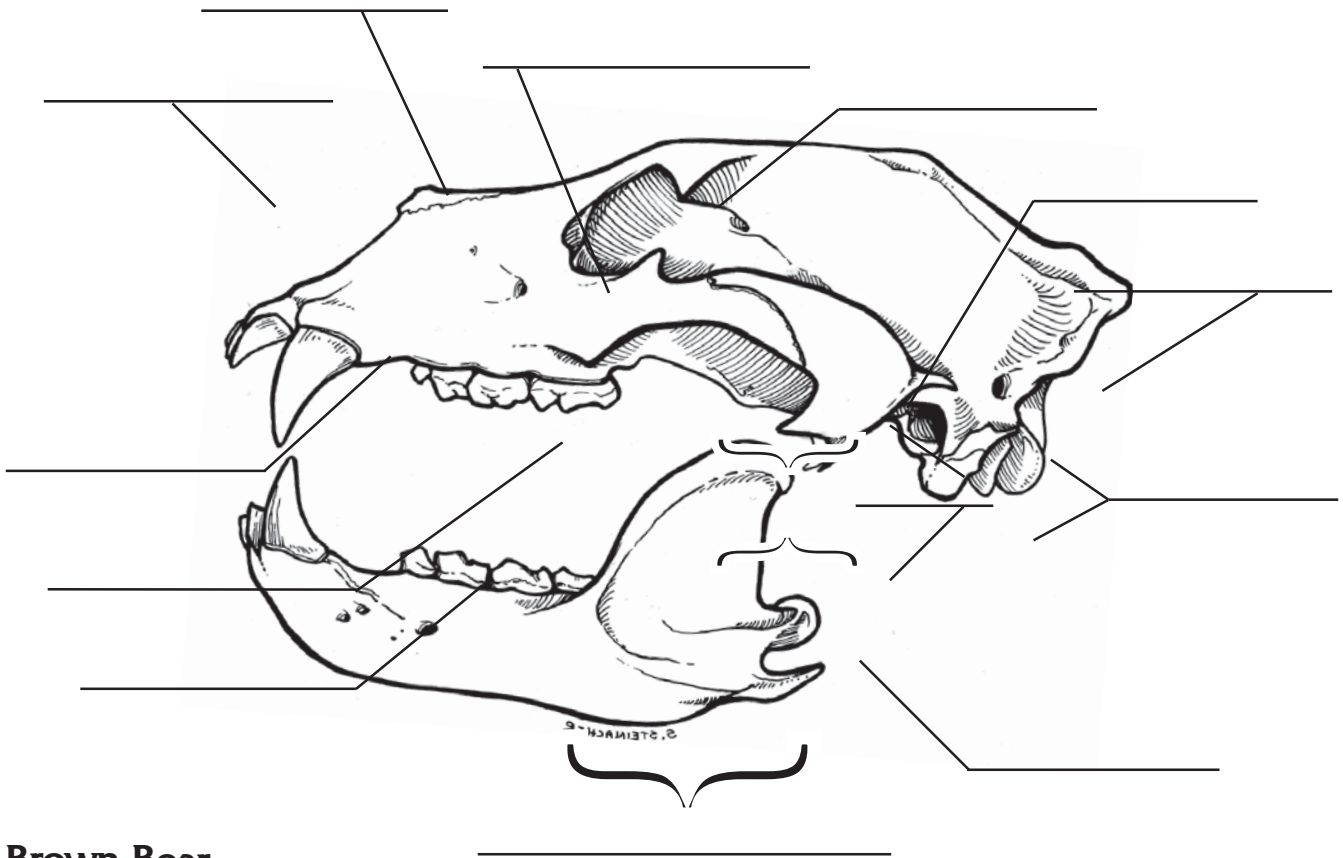
The auditory bullae are the bony structures that encase the inner ear. Inflated auditory bullae indicate a well developed sense of hearing.

Does this animal rely strongly on its sense of smell?

The size of the nasal passage indicates an animal's sense of smell. There are intricate structures within the nasal cavity providing structure for the membranes that sense odor. For example, lynx have short nasal passages, indicating a weaker sense of smell than members of the canine family, like coyotes or wolves.

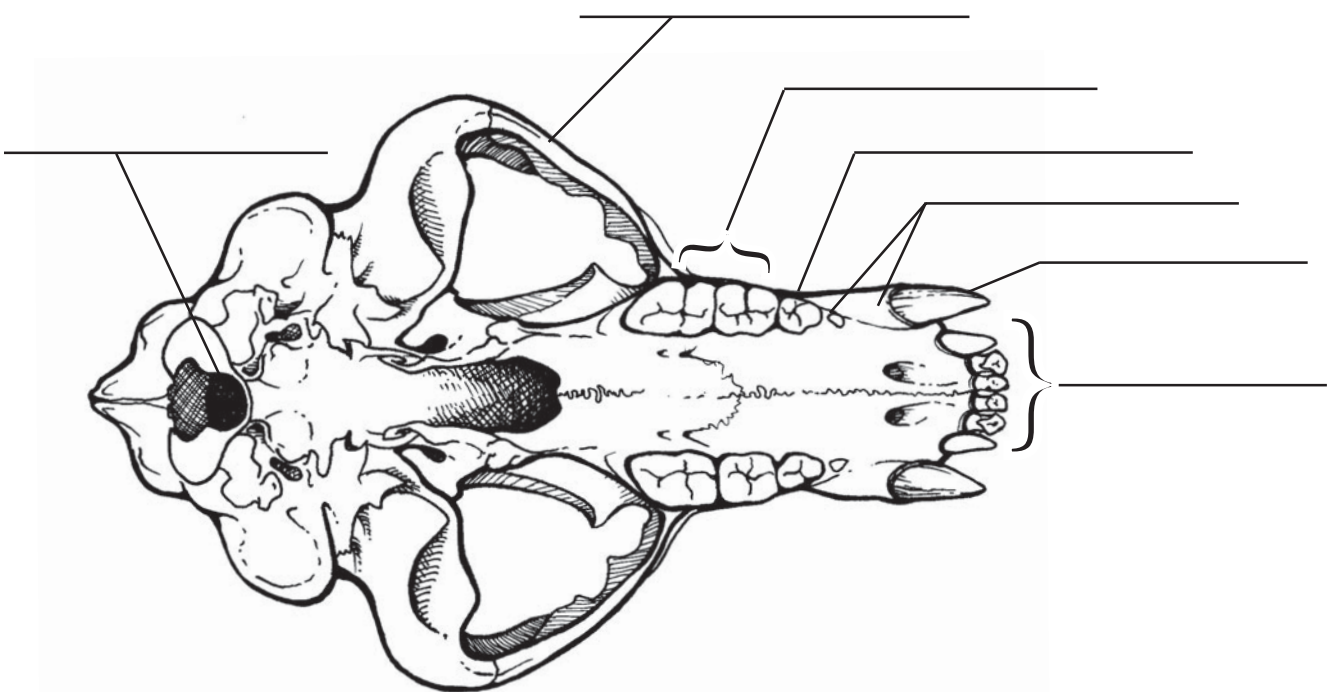


Skulls Worksheet #1

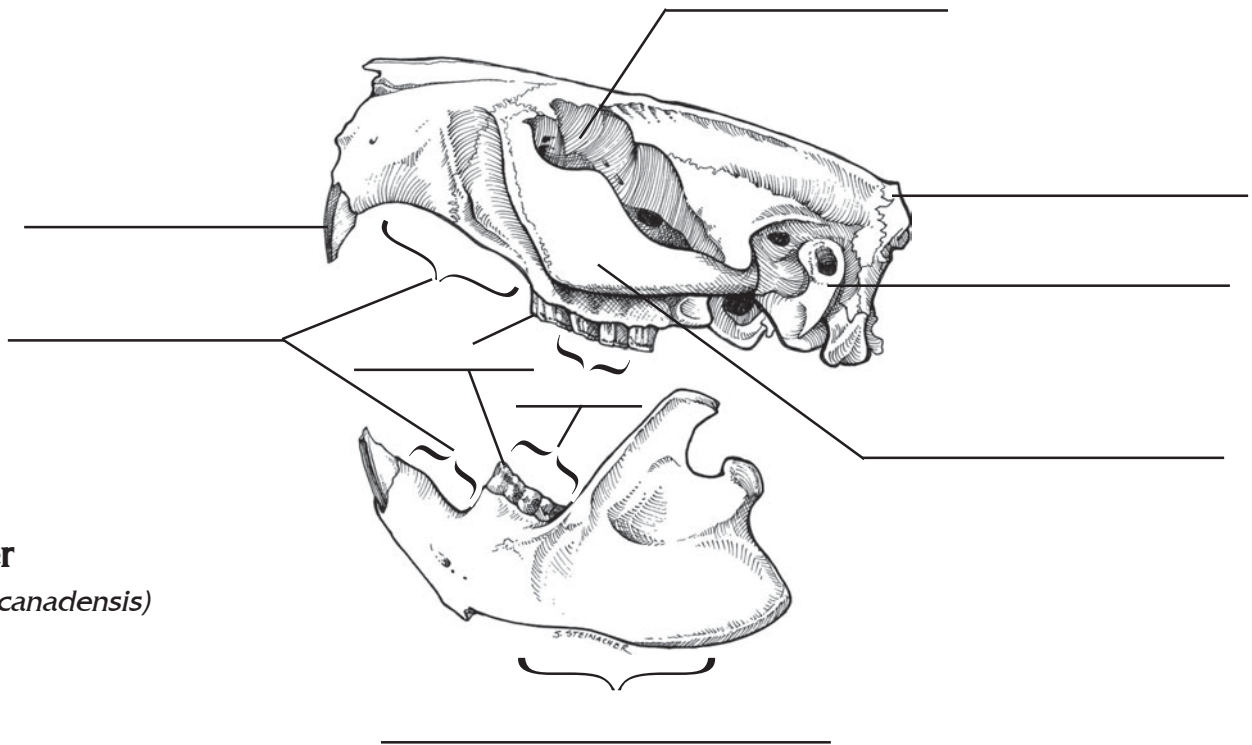


Brown Bear

(*Ursus arctos*)

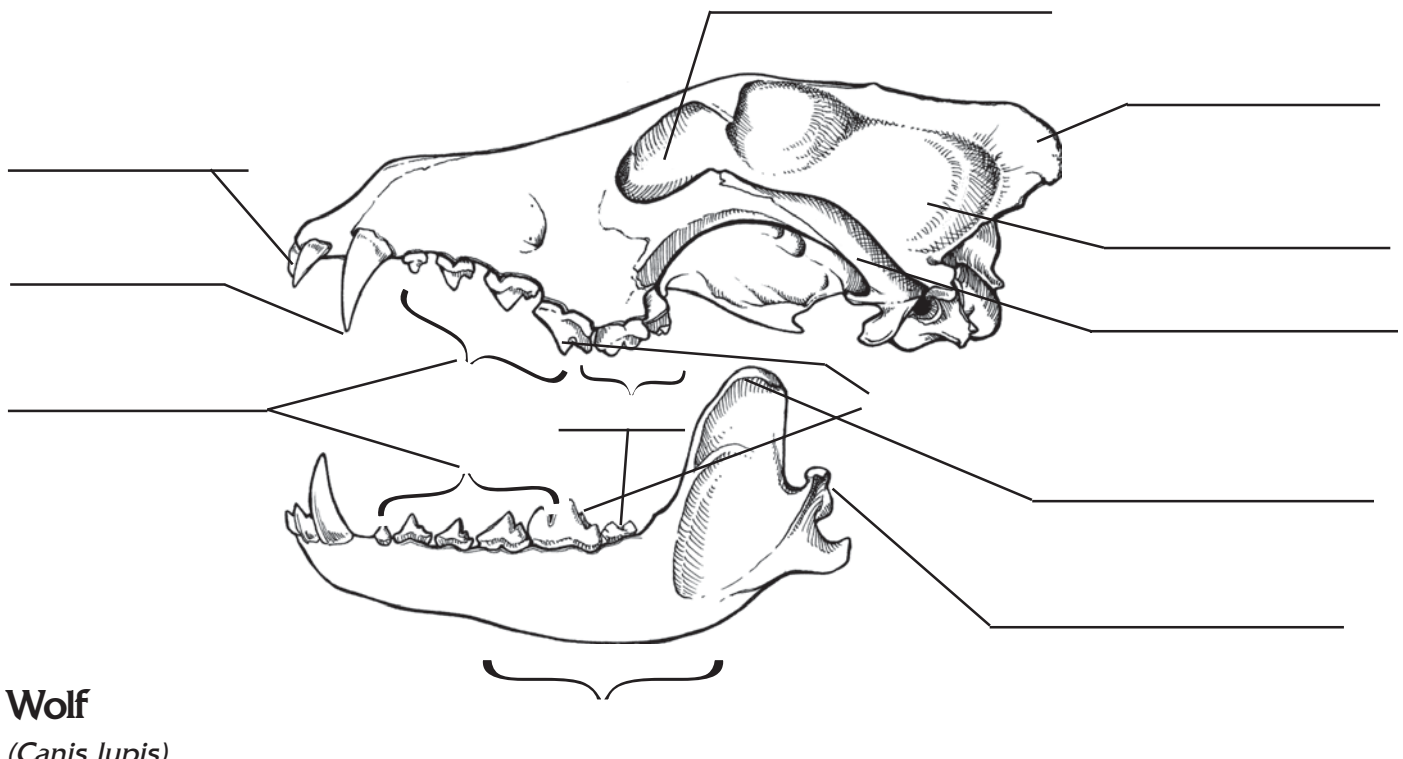


Skulls Worksheet #2



Beaver

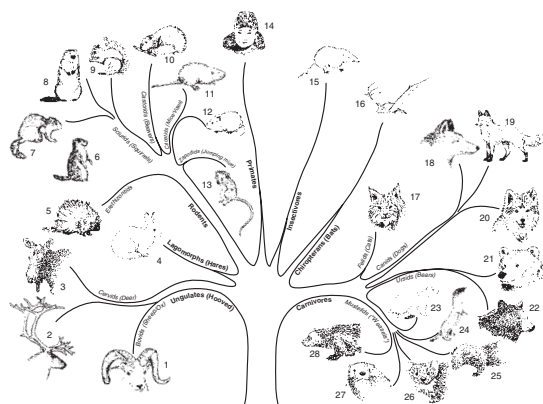
(*Castor canadensis*)



Wolf

(*Canis lupis*)

B. Who's Related to Whom?



Skull Activities

Grade Levels: Grades 3 - 8

Duration: 1 hour

Science Standards: A1 and C2

Skills: classifying, sorting, observing, communicating

Vocabulary: carnivore, incisors, herbivore, omnivore, habitat, canine, molar

Objectives

The learner will be able to:

- Compare and contrast skull characteristics.
- Sort skulls into related groups.
(i.e. carnivore, herbivore, omnivore)
- Identify skulls by Order, Family and Species.
- Cooperate with team members to answer questions about skulls.

Methods

Working in small groups, students will make observations at skull stations with a set of skulls, answer questions based on their observations, and classify the skulls to family groups and possibly down to species.

Background

Refer to 'About Skulls' section.

Materials

- Skull sets with two or more from representative Order/Families (canids, weasels, rodents, hare or rabbit, bear, deer or moose, etc.)
- Family tree chart of Native Mammals of (your region) from Sec. 6 of guide (1/student).
- Family tree chart of Native Mammals of (your region) transparency (to be created by teacher from Sec. 6 of this guide).
- Family tree worksheet questions copied from Sec. 6 of guide (1/student).
- Skull Mystery Questions from following page (copied by teacher for each skull station)

Special Note: If skulls are labeled, cover label with tape so students can identify them for themselves.

Procedures

Introduction:

(Students should have completed the introductory 'Skull Detective' activity prior to this lesson.)

Hold up a large skull for the class to spark their interest and participation. Ask the students to tell the class what they know about an animal by looking at its skull. Allow students to share several examples, then continue to ask review questions. **What are the animals called that eat only meat?** (carnivores) **Only plants?** (herbivores) **Plants and meat?** (omnivores)

Explain to the students that they will be learning more about these groups of mammals by studying their skulls. They will begin to identify the animals that are related, eventually identifying them to their individual species.

1. The Family Tree:

Order, Family & Species

Display the family tree overhead transparency of 'Native Mammals of (your region) Alaska.' Each student should have their own copy of their region's family tree and the accompanying Family Tree Worksheet. Ask questions from the worksheet to invite closer inspection of the family tree.

Even if students are not familiar with animal classification, if they use the appropriate terminology they will become familiar with the differences between order, family and species when separating the skulls later on. The family tree will give students a visual way of seeing the relationships between families.

Some additional questions:

Dogs are part of a larger group (Order) of animals. *What do you call them?* (Carnivores)

Are porcupines a kind of rodent? How do you know by looking at the family tree? (The porcupine is one of the branches coming off of the rodents branch (Order).)

What families belong to the Order of hoofed animals? (Goats, Moose, Deer)

2. Skull Mystery Stations

Before students begin this activity, remind them about handling the skulls carefully.

Students will be working in small groups making observations and applying their knowledge of skulls to answer the skull mystery questions.

Tell students that they will present their observations to the class when they are done. Have students share their answers with one another after all of the students have completed each station.

Setting up the skull stations: If your skull collection does not have these particular skulls, replace them with related skulls from same Order.

Sample Skull Mystery Questions (modify these to fit your skull options):

Station 1. Black bear and brown bear skulls:
Compare these two skulls. Are they the same kind of mammal? What do they have in common? How are they different?

Station 2. Porcupine, beaver and squirrel skulls:
Are these animals related to one another? How are these skulls different from one another? What do you notice about the incisors? How do these teeth

help the animals get food?

Station 3. Wolf, weasel and coyote or fox skulls:
Are these animals' herbivores, carnivores or omnivores? How do you know? Are they closely related? Why or why not?

Station 4. Deer, moose or caribou - jaws or skulls:
Are these animals' herbivores, carnivores or omnivores? How do you know? Which jaw is the oldest? How do you know?

Station 5. Wolverine and wolf skulls: *How is the motion of the jaw different in each skull? Why do you think this is the case?*

Station 6. Seal and sea lion skulls: *What type of food do you think these animals eat? (Look carefully at the shape and spacing of the teeth.) Are these animals related?*

Bring the students back together and sit in a circle. Start with the first station and ask for a representative from one group to share their observations. Then ask the next group to address another station and so on, until observations from all of the stations have been discussed.

3. Who's Related to Whom?

Divide the class into two or three groups, depending on the number/variety of skulls available.

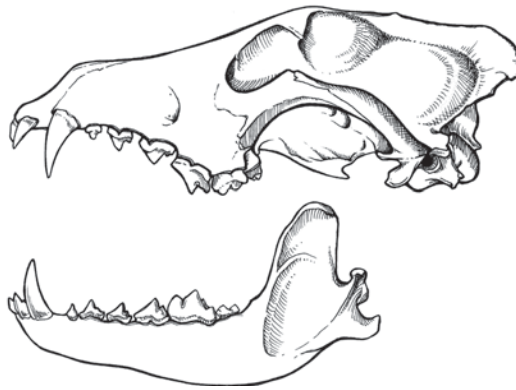
Place a set of skulls at a table group. (Skulls should represent different orders and there should be a few representatives for each order, including some animals within the same family.)

Ask the students to sort the skulls into groups, initially by those that are carnivores, herbivores and omnivores. Then sort them into more closely related groups. Students then use their Native Mammals of Alaska Family Tree worksheet to match the skulls to their families.

4. Wrap-Up

Have student groups discuss their results. Solicit ideas about the identity of individual skulls.

3. Drawing Skulls



Objectives

The learner will be able to:

- Make observations of skull characteristics and its details.
- Use drawing to convey the character of individual skulls.
- Apply creative skills to better understand taxonomy.
- Use skull characteristics to identify to family and species.
- Learn a technique for drawing 3-D images.

Methods

Drawing utilizes a different part of the brain, and brings another dimension to skull exploration. Drawing will encourage greater visual examination and familiarity with skull anatomy.

Background

Review 'About Skulls' section and the 'Who's Related to Whom?' activity ahead of time.

Materials

- Larger skulls from collection
- Family tree chart of Native Mammals of your region

For each student:

- Tracing paper and drawing paper
- Soft-lead pencil and harder-lead pencil
- Eraser

Drawing Skulls

Grade Levels:

- Grades 3 - 8 (sketching only)
- Grades 9 - 12 (3-D techniques)

Duration: 1 hour or two
30- minute sessions

Science Standards: C 2 and F 2

Skills: observing, inferring, classifying

Vocabulary: canines, carnivore, cranium, herbivore, incisors, molars, omnivore, predator, prey

For each student group:

- A piece of glass larger than the skull to be drawn. (Picture frame glass will work)
- Fine-tipped permanent marker that will write on and erase from glass or clear mylar.
- Soft cloth (and glass cleaner, if needed)
- Index card w/ peephole (hole punch size)
- 1 ring stand w/clip (or other devised method) to hold index card
- 1 ring stand w/clasp (or other devised method) to hold glass securely

Note: If you do not have this much equipment available just set up one drawing station and give each student a turn.

Procedures

Before you begin!

It is highly recommended the you try this entire procedure on your own before guiding the students through it. It may seem confusing at first, but once you understand the set-up and the steps it becomes a useful technique for turning 3-D objects into 2-D drawings.

1. Introducing the activity

Divide class into several groups and provide each group with a skull. Have students take time to observe individual skulls, paying attention to shape, orbits, teeth, foramina, texture etc.

Discuss the skulls and ask questions. ***Are the skulls scary? interesting? What is the most interesting part of the skull?***

Pass out the Mammal Family Tree worksheet and give students time to see if they can match their skull to its 'family'. Give each group an opportunity to present and discuss their guess.

2. Setting up for drawing skulls

Prop skull in whatever position it is to be drawn.

Using a ring stand, or some other inventive method, securely affix an upright piece of glass in front of the skull.

Using the second ring stand, or some other inventive method, affix an index card or other stiff paper with a small peep-hole in it at eye height. It is important that the hole be small and immovable. This prevents any shifting of perspective while tracing, and maintains accuracy.

3. Tracing the skull

Looking through a fixed peep-hole, the student carefully traces the shapes of the skull onto a fixed piece of glass using a fine-tipped permanent marker. This may take some time as skulls are complex structures, but the reward will be worth the effort!

4. Transferring the image

Once the drawing is completed on the glass the student needs to transfer the image. If you have a light source to place the glass in front of, such as a window, you will be able to trace the drawing on the glass directly onto good paper.

Without a backlit source you can easily make a transfer of the glass drawing. To make a transfer lay tracing paper over the drawing on glass and retrace. Then rub the back side of the tracing paper using the side of a soft pencil. Place this on top of a

good piece of paper and retrace the drawing. The pressure of the pen or pencil will leave a graphite line on the paper.

Wipe the glass clean for the next student.

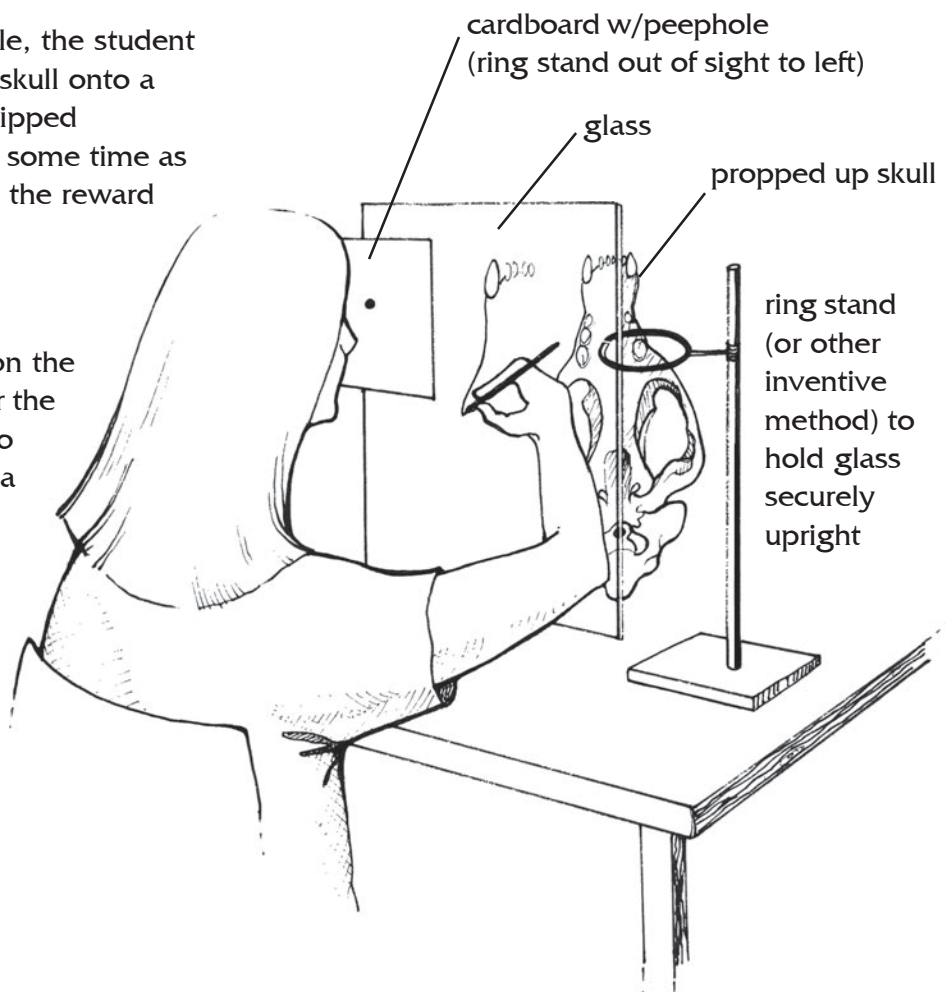
5. Finishing the drawing

Draw with ink or a marker over the transferred tracing and then erase the pencil lines and smudges. Voila! This method will work for accurately drawing any 3-D object, not just skulls.

6. Wrap-up

Discuss what the students discovered in the process of drawing. Create a display on the wall with pictures of skulls branching out by mammal families, as shown on the family tree chart of Native Mammals of your region. (Don't worry if some students don't want to share their drawings.)

Admire all the drawings!



D. Dichotomous Keys:

A biologist's puzzle solver



Objectives

The learner will:

- Understand what a dichotomous key is and how to use one.
- Distinguish characteristics of a group of organisms.
- Create a skulls key.

Methods

Explain the use of the sample student key and then have students create a key for the entire class.

Have students create a matching/sorting list of skull characteristics.

Have students develop a key using the skull collection.

Materials

Skull Collection

Procedures

Introduction:

A dichotomous key, which is used to identify an unknown plant or animal species, is a very important tool used by biologists. A dichotomous key is made up of many points, each with 2 parts.

1. Making a key of students.

The students will create a key to identify the individual students in their classroom using unique characteristics. Use an overhead projector or the

board to get the class started in creating the divisions. Broad characteristics shared by many class members would be the first divisions.

Examples of broad characteristics are hair color, eye color and height. These groups of students could be considered as 'families.'

To further divide the class to individuals use more specific characteristics, such as hair style; color of clothing; or whether or not the student is wearing braces, jewelry, barrettes, or glasses. Then allow students to create their own key.

The following is an example of a hypothetical group of six students. A key is usually used to identify something *unknown* down to species, but in this example individual names take the place of species.

1. Hair brown go to 2.
Hair not brown go to 4.
2. Eyes green. Arthur
Eyes not green. go to 3.
3. Eyes blue. Patrick
Eyes brown. Rhonda
4. Hair red and wavy. John
Hair not red and wavy. go to 5.
5. Hair black, long and in braids. ... Theresa
Hair black and short. Allen

Dichotomous Keys

Grade Levels: Grades 5 - 12

Duration: 1 hour

Science Standards: C2 & G3

Skills: classifying, observing, sorting.

Vocabulary: (Refer to the 'About Skulls' section and glossary.)

2. Use a key to identify a mystery skull

The following is an example of a key for identifying skulls. Using this key give students an unknown skull and see if they can identify it using the key below. (Make sure you hand out a skull that is in the key.) Also, note that the term **rostrum** refers to the nose or snout of the skull.

1. Wide diastema (space) between incisors and cheek teeth go to 2
No obvious diastema between incisors and cheek teeth go to 6
2. Incisors $\frac{2}{1}$; rostrum extensively perforated **snowshoe hare**
Incisors $\frac{1}{1}$ or $\frac{0}{3}$; rostrum not extensively perforated go to 3
3. Incisors $\frac{1}{1}$, may be orange; skulls small, length 150 mm or less.... Rodentia, go to 4
Incisors $\frac{0}{3}$, not orange; skull length 300 mm or greater Artiodactyla, go to 5
4. Skull small, 70 mm or less **muskrat**
Skull massive, deeply grooved on side of rostrum, 120-150 mm in length .. **beaver**
5. Canines $\frac{1}{1}$ (upper may be missing but root socket present);
skull length 300-400 mm; antlers seasonally present in both sexes **caribou**
6. Canines $\frac{0}{1}$; skull length ~500mm; antlers seasonally in male only, palmate .. **moose**
7. Rostrum (nose) short and blunt; orbit large; cheek teeth shearing,
without grinding surfaces, molars $\frac{1}{1}$, total number of teeth 28 **lynx**
8. Rostrum more or less short and blunt; total number of teeth 34 or 38. Mustelidae, go to 9
Rostrum (nose) long; total number of teeth 42 go to 10
9. Total number of teeth 34; length of skull approximately 57 mm **mink**
Total number of teeth 38; length of skull approximately 80 mm. **marten**
10. Rostrum long and narrow; cheek teeth with shearing & grinding surfaces ... Canidae, go to 11
Rostrum broad; premolars rudimentary or lost, molars broad and flat Ursidae, go to 12
11. Length of skull 105 to 122 mm. **red fox**
Length of skull 230 to 290 mm **wolf**
12. Last upper molar not more than 31 mm **black bear**
Last upper molar 38 mm or longer **brown bear**

3. Practice by sorting & matching

When the students understand what a key is and how a key is made, have them make their own key to the skulls. A matching and sorting exercise may help the students begin constructing the key. For example list the animals in one column and lettered characteristics in another column:

beaver	b, j	a. Long nose
muskrat	b, d	b. Space between front teeth and cheek teeth
hare	b	c. Sharp, pointed canine teeth, cheek teeth flat
moose	a, b, f	d. Orange incisors, total teeth = 16
caribou	b, e	e. No upper incisors, upper canines present, total teeth = 34
mink	g, h	f. No upper incisors or canines, total teeth = 32
lynx	g, h, i	g. Snout short and blunt, braincase expanded
wolf	a, h	h. Sharp, pointed canine and cheek teeth
bear	a, c	i. Orbits large
		j. Orange incisors, total teeth = 20

4. Students make their own key to the skulls

The following is an example of how you might create a key that separates herbivores from carnivores based on differences in their teeth. Refer to the key on the opposite page for ideas on how to organize skulls by their features. Now have students make their own key to the skulls!

1. Wide diastema (space) between front teeth and cheek teeth. go to 2
No conspicuous, wide space between front teeth and cheek teeth. go to 6
2. Peg-like teeth present behind upper incisors; skull perforated snowshoe hare
(Lepus americanus)
No peg-like teeth present behind upper incisors;
skull entire, without perforations go to 3
3. Number 3 could separate the rodents from the hoofed mammals by comparing the lack or presence of upper incisors and the size of the skulls.
Number 4 could separate the beaver and muskrat based on size, lack or presences of premolars, and the difference in the tooth crown patterns.
Moose and caribou would be sorted out in number 5.
Carnivore sorting could then begin at number 6.

4. Alaska Mammal Family Trees

Including:

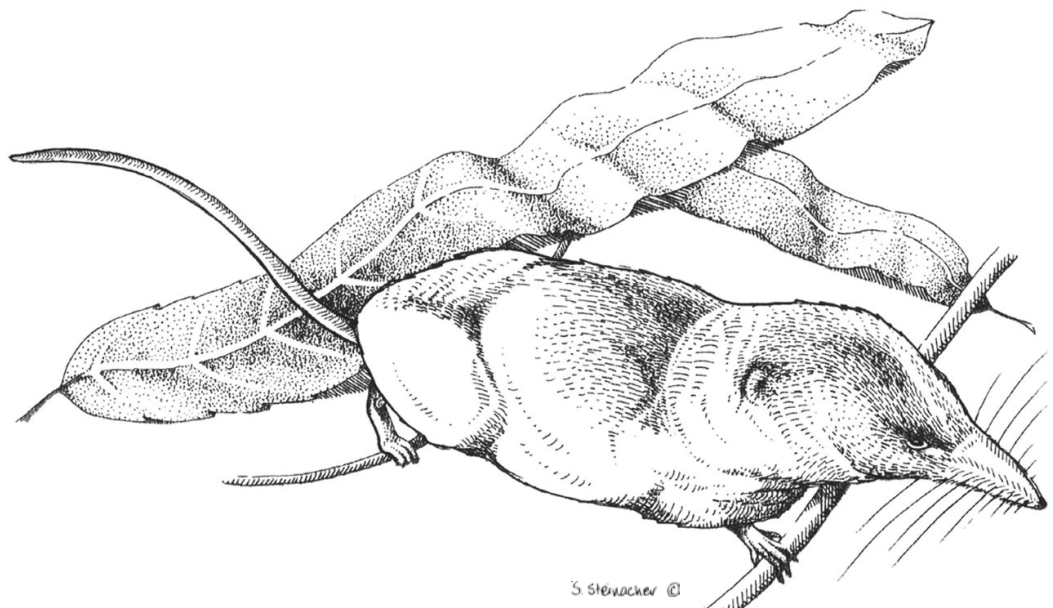
Family Tree Charts

Family Tree Worksheets

Answer Keys

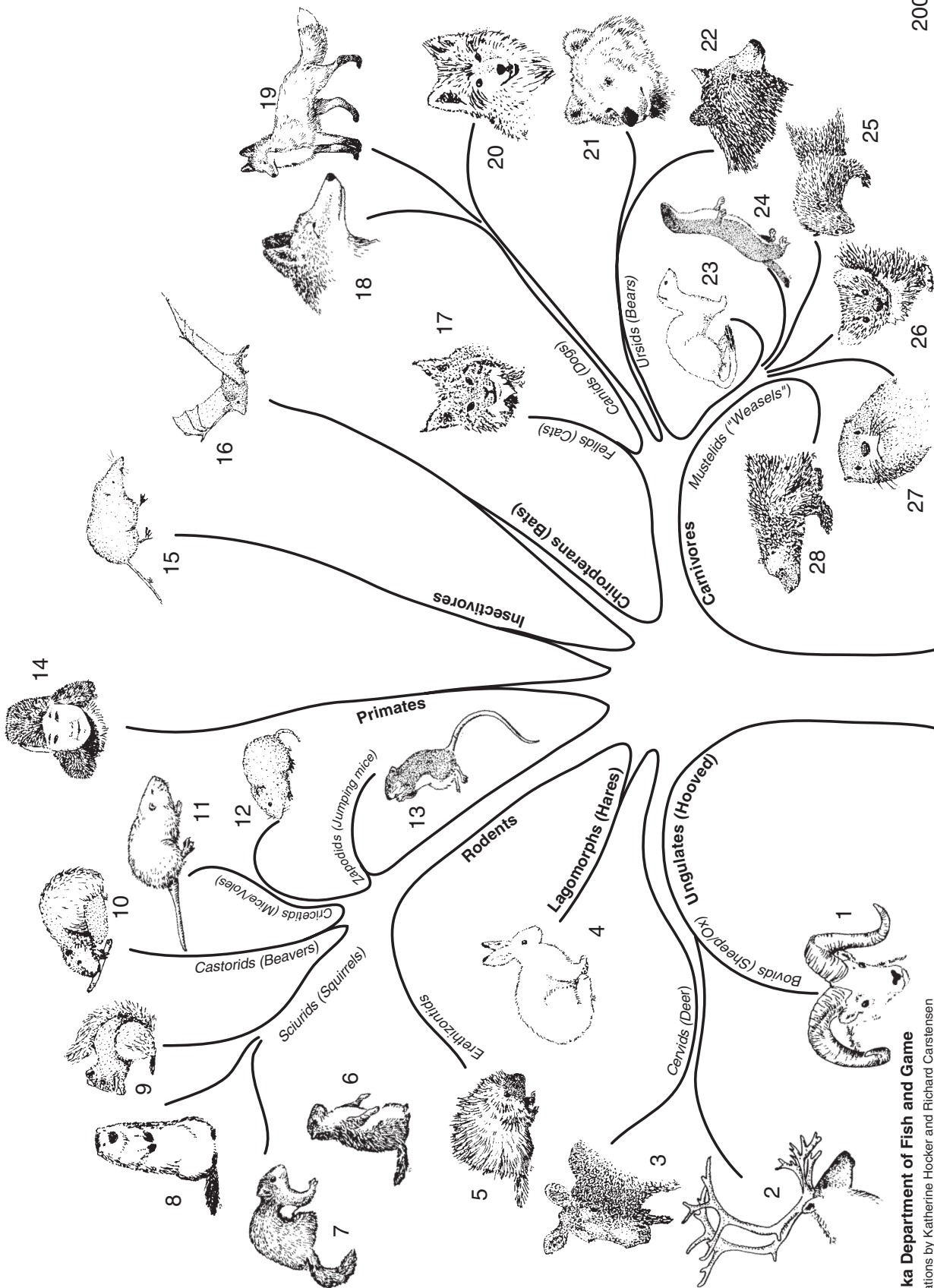
Please note: If you would like to see the following species grouped according to their families and orders, please refer to the UAF Museum website at:

www.uaf.edu/museum/mammal/AK_Mammals/Checklist.html



Native Mammals of Interior Alaska

Mammal orders are shown in **bold**;
families- are shown in *italics*.



Alaska Department of Fish and Game

Illustrations by Katherine Hocker and Richard Carstensen

2003

Native Mammals of Interior Alaska

- | | |
|---------------------------|--------------------------|
| 1. Dall sheep | 17. lynx |
| 2. caribou | 18. coyote |
| 3. moose | 19. red fox |
| 4. snowshoe hare | 20. wolf |
| 5. porcupine | 21. brown (grizzly) bear |
| 6. Arctic ground squirrel | 22. black bear |
| 7. flying squirrel | 23. ermine |
| 8. marmot | 24. least weasel |
| 9. red squirrel | 25. mink |
| 10. beaver | 26. marten |
| 11. muskrat | 27. river otter |
| 12. voles | 28. wolverine |
| 13. meadow jumping mouse | |
| 14. human | |
| 15. shrews | |
| 16. bat | |

Family Tree Worksheet - Interior Alaska Mammals

What is a mammal?

Mammals are a group of warm-blooded animals that feed their babies _____.

Why sort mammals into groups?

To make it easier to study animals, scientists put them into groups based on common characteristics. Related species (kinds) of mammals are placed together on a 'branch' of the mammal family tree. This is called **classifying** them.

What do all of the animals on the *rodent* branch have in common? _____

What do all of the animals on the *ungulate* branch have in common? _____

What are mammal 'Orders'?

The big branches on the family tree are 'orders.' For example, the big branch that includes wolves and black bears is the order of *carnivores*.

What are some other local mammals that are in the order of *carnivores*?

_____, _____

Mammals that are part of the same order share common characteristics.

Which order of mammals has sharp incisors (nipping teeth) that grow continually? _____

Which order has canine (fang) teeth? _____

What are mammal 'Families'?

Medium-sized branches that come from an 'order' branch are called 'family' branches. For example, the branch that includes wolverines and martens is the family of *weasels* within the order of *carnivores*.

What are some other members of the 'weasel' family? _____ and _____

What family does a red squirrel belong in? _____

What family does a muskox belong in? _____

Where are you on the mammal family tree?

The human is number _____ on the branch called _____. Follow that branch down to the base of the tree. You are a mammal!

Who's missing?

Can you find any native mammals of Interior Alaska that are missing from this mammal family tree? (hint: look in the orders of *rodents* and *carnivores*).

_____, _____, _____

Answer Key for

Family Tree Worksheet - Interior Alaska Mammals

What is a mammal?

Mammals are a group of warm-blooded animals that feed their babies milk.

Why sort mammals into groups?

What do all of the animals on the *rodents* branch have in common? orange enamel on incisors.

What do all of the animals on the *ungulate* branch have in common? horns or antlers, two-toed hooves.

What are mammal 'Orders'?

What are some other local mammals that are in the order of *carnivores*? wolverine, weasel, otter.

Which order of mammals has sharp incisors (nipping teeth) that grow continually? Rodents.

Which order has canine (fang) teeth? Carnivores.

What are mammal 'Families'?

What are some other members of the "weasel" family? otter, and mink.

What family does a red squirrel belong in? Sciuridae.

What family does a muskox belong in? Bovidae.

Where are you on the mammal family tree?

The human is number 14, on the branch called primates.

Who's missing?

Can you find any native mammals of Interior Alaska that are missing from this mammal family tree? (hint: look in the orders of *rodents* and *carnivores*).

bog lemming, woodchuck, Norway rat, house mouse, arctic fox.

Native Mammals of Northern and Western Alaska

Mammal orders are shown in **bold**;
families are shown in *italics*.



Alaska Department of Fish and Game
Illustrations by Katherine Hocker and Richard Carstensen

Native Mammals of Northern & Western Alaska

- | | |
|---------------------------|--------------------------|
| 1. caribou | 17. lynx |
| 2. moose | 18. red fox |
| 3. muskox | 19. Arctic fox |
| 4. Dall sheep | 20. wolf |
| 5. Arctic hare | 21. black bear |
| 6. voles | 22. brown (grizzly) bear |
| 7. lemming | 23. polar bear |
| 8. Arctic ground squirrel | 24. walrus |
| 9. red squirrel | 25. ribbon seal |
| 10. beaver | 26. spotted seal |
| 11. human | 27. ermine |
| 12. shrews | 28. least weasel |
| 13. bowhead whale | 29. marten |
| 14. gray whale | 30. mink |
| 15. orca (killer whale) | 31. wolverine |
| 16. beluga | |

Family Tree Worksheet - Northern & Western Alaska Mammals

What is a mammal?

Mammals are a group of warm-blooded animals that feed their babies_____.

Most mammals have fur or hair, and most have several different types of teeth in their mouths.

Not all mammals fit all of these categories! Find a mammal that has almost no hair :_____

Find a mammal with no teeth: _____

Why sort mammals into groups?

To make it easier to study animals, scientists put them into groups based on common characteristics.

Related species (kinds) of mammals are placed together on a 'branch' of the mammal family tree. This is called 'classifying' them.

What do all of the animals on the *rodent* branch have in common? _____

What do all of the animals on the *ungulate* branch have in common? _____

What are mammal 'orders'?

The big branches on the family tree are 'orders.' For example, the big branch that includes wolves and black bears is the order of *carnivores*.

What are some other local mammals that are in the order of *carnivores*?

_____, _____

Mammals that are part of the same order share common characteristics.

Which order of mammals has sharp incisors (nipping teeth) that grow continually?_____

Which order has canine (fang) teeth? _____

What are mammal 'families'?

Medium-sized branches that come from an 'order' branch are called 'family' branches. For example, the branch that includes wolverines and martens is the family of *weasels* within the order of *carnivores*.

What are some other members of the 'weasel' family? _____ and _____

What family does a red squirrel belong in? _____

What family does a muskox belong in? _____

Where are you on the mammal family tree?

The human is number _____ on the branch called _____. Follow that branch down to the base of the tree. You are a mammal!

Who's missing?

Can you find any native mammals of northern/western Alaska that are missing from this mammal family tree? (hint: look in the orders of *rodents*, *cetaceans*, and *carnivores*).

_____, _____, _____

Answer Key for

Family Tree Worksheet - Northern & Western Alaska Mammals

What is a mammal?

Mammals are a group of warm-blooded animals that feed their babies milk.

Find a mammal that has almost no hair: bowhead whale.

Find a mammal with no teeth: gray whale.

Why sort mammals into groups?

What do all of the animals on the *rodents* branch have in common? orange enamel on incisors.

What do all of the animals on the *ungulate* branch have in common? horns or antlers, two-toed hooves.

What are mammal 'Orders'?

What are some other local mammals that are in the order of *carnivores*? wolverine, weasel, otter.

Which order of mammals has sharp incisors (nipping teeth) that grow continually? Rodents.

Which order has canine (fang) teeth? Carnivores.

What are mammal 'Families'?

What are some other members of the "weasel" family? otter, and mink.

What family does a red squirrel belong in? Sciuridae.

What family does a muskox belong in? Bovidae.

Where are you on the mammal family tree?

The human is number 11, on the branch called primates.

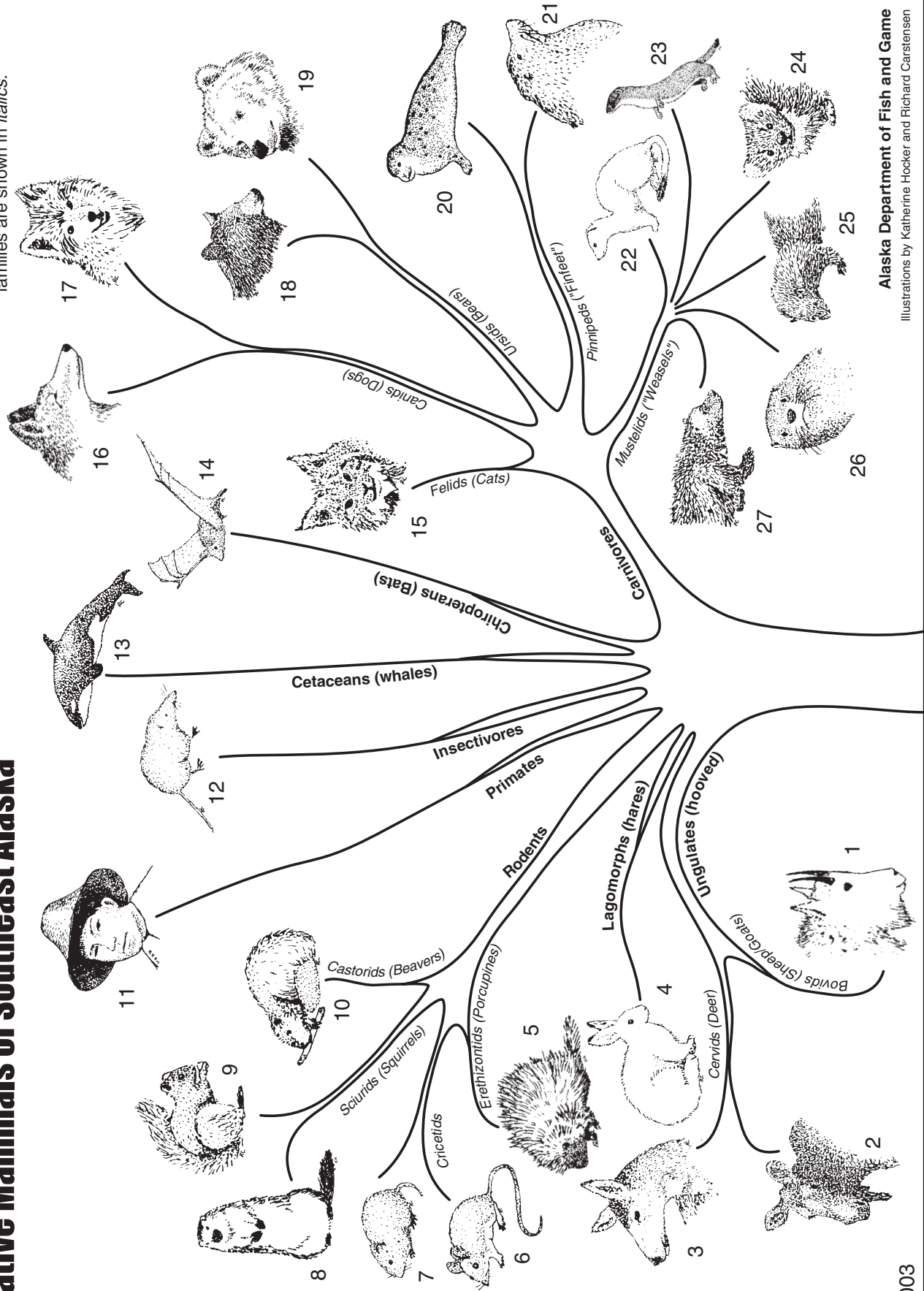
Who's missing?

Can you find any native mammals of northern/western Alaska that are missing from this mammal family tree? (hint: look in the orders of *rodents*, *cetaceans*, and *carnivores*).

jumping mouse, muskrat, Norway rat, house mouse, blue whale, coyote.

Native Mammals of Southeast Alaska

Mammal orders are shown in **bold**;
families are shown in *italics*.



Alaska Department of Fish and Game
Illustrations by Katherine Hocker and Richard Carstensen

Native Mammals of Southeast Alaska

- | | |
|----------------------------|------------------|
| 1. mountain goat | 15. lynx |
| 2. moose | 16. coyote |
| 3. Sitka black-tailed deer | 17. wolf |
| 4. snowshoe hare | 18. black bear |
| 5. porcupine | 19. brown bear |
| 6. deer mouse | 20. harbor seal |
| 7. voles | 21. sea lion |
| 8. marmot | 22. ermine |
| 9. red squirrel | 23. least weasel |
| 10. beaver | 24. marten |
| 11. human | 25. mink |
| 12. shrews | 26. river otter |
| 13. orca (killer whale) | 27. wolverine |
| 14. bat | |

Family Tree Worksheet - Southeast Alaska Mammals

What is a mammal?

Mammals are a group of warm-blooded animals that feed their babies_____.

Most mammals have fur or hair, and most have several different types of teeth in their mouths.

Not all mammals fit all of these categories! Find a mammal that has almost no hair :_____

Why sort mammals into groups?

To make it easier to study animals, scientists put them into groups based on common characteristics.

Related species (kinds) of mammals are placed together on a 'branch' of the mammal family tree. This is called 'classifying' them.

What do all of the animals on the *rodent* branch have in common? _____

What do all of the animals on the *ungulate* branch have in common? _____

What are mammal 'orders'?

The big branches on the family tree are 'orders.' For example, the big branch that includes wolves and black bears is the order of *carnivores*.

What are some other local mammals that are in the order of *carnivores*?

_____, _____, _____

Mammals that are part of the same order share common characteristics.

Which order of mammals has sharp incisors (nipping teeth) that grow continually? _____

Which order has canine (fang) teeth? _____

What are mammal 'families'?

Medium-sized branches that come from an 'order' branch are called 'family' branches. For example, the branch that includes wolverines and martens is the family of *weasels* within the order of *carnivores*.

What are some other members of the 'weasel' family? _____ and _____

What family does a red squirrel belong in? _____

Where are you on the mammal family tree?

The human is number _____ on the branch called _____. Follow that branch down to the base of the tree. You are a mammal!

Who's missing?

Can you find any native mammals of nSoutheast Alaska that are missing from this mammal family tree? (hint: look in the orders of *rodents*, *cetaceans*, and *carnivores*).

_____, _____, _____

Answer Key for

Family Tree Worksheet - Southeast Alaska Mammals

What is a mammal?

Mammals are a group of warm-blooded animals that feed their babies milk.

Find a mammal that has almost no hair: harbor seal.

Why sort mammals into groups?

What do all of the animals on the *rodents* branch have in common? orange enamel on incisors.

What do all of the animals on the *ungulate* branch have in common? horns or antlers, two-toed hooves.

What are mammal 'Orders'?

What are some other local mammals that are in the order of *carnivores*? wolverine, weasel, otter.

Which order of mammals has sharp incisors (nipping teeth) that grow continually? Rodents.

Which order has canine (fang) teeth? Carnivores.

What are mammal 'Families'?

What are some other members of the "weasel" family? otter, and mink.

What family does a red squirrel belong in? Sciuridae.

Where are you on the mammal family tree?

The human is number 11, on the branch called primates.

Who's missing?

Can you find any native mammals of Southeast Alaska that are missing from this mammal family tree?
(hint: look in the orders of *rodents*, *cetaceans*, and *carnivores*).

jumping mouse, long-tailed vole, bog lemming, Norway rat, house mouse, humpback and minke whales, red fox.

5. Student Study Cards



S. Steinacher ©

snowshoe hare

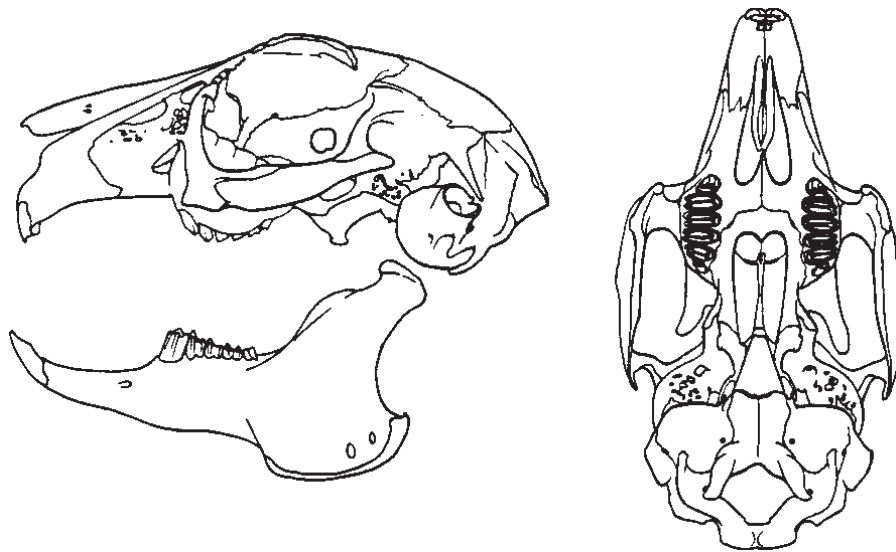
Order: LAGOMORPHA

Family: Leporidae

Genus: Lepus

species: americanus

dental formula: $I \frac{2}{1}, C \frac{0}{0}, P \frac{3}{2}, M \frac{3}{3} = 28$



The **snowshoe hare** skull has a diastema (wide space) between the front teeth (incisors) and the cheek teeth (premolars and molars).

Immediately behind the upper, front teeth is a set of peg-like teeth. The hare is the only Alaskan mammal with pegged teeth.

Hares and rodents are unique from the other mammals in that they lack canine teeth.

The side of the hare skull, in front of the eye sockets, has many perforations or openings.

beaver

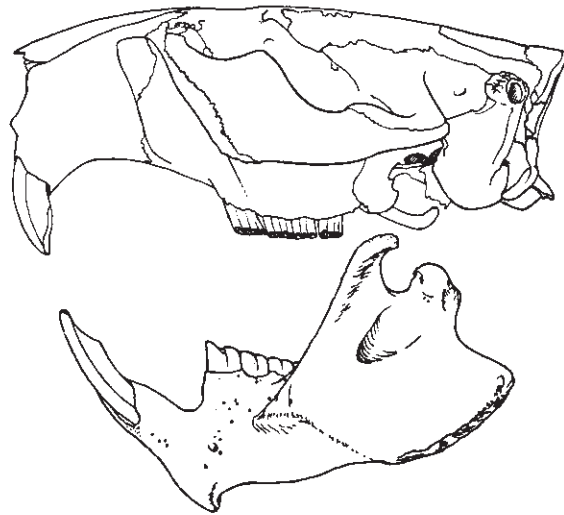
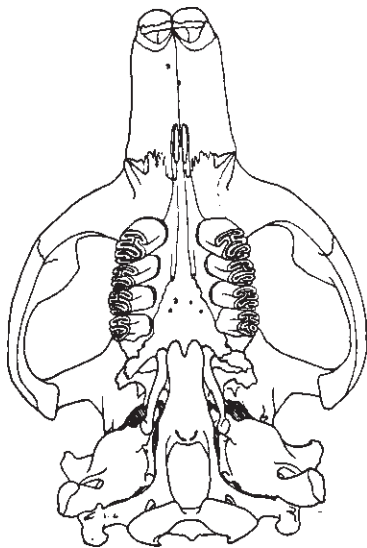
Order: RODENTIA

Family: Castoridae

Genus: Castor

species: canadensis

dental formula: $I \frac{1}{1}, C \frac{0}{0}, P \frac{1}{1}, M \frac{3}{3} = 20$



The **beaver** has a diastema (wide space) between the front teeth and the cheek teeth, as does the hare. All rodents have one set of front teeth in the upper and lower jaw.

Beaver use their continuously growing orange incisors to cut and chip wood.

The skull is large and heavy to support the stress and strain of the huge cheek muscles necessary to cut wood.

The average adult skull is approximately 120 mm (4.8 inches) in length.

muskrat

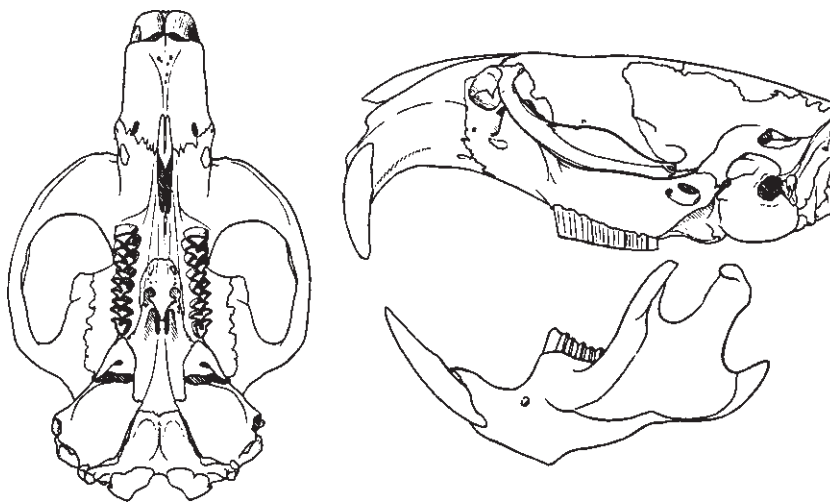
Order: RODENTIA

Family: Cricetidae

Genus: Ondatra

species: zibethicus

dental formula: $I \frac{1}{1}, C \frac{0}{0}, P \frac{0}{0}, M \frac{3}{3} = 16$



At first glance the **muskrat** skull looks like a miniature beaver skull.

It has just three sets of molars and the crown pattern is triangular compared to the beaver's grooved crown pattern.

The average adult muskrat skull is approximately 60 mm (2.4 inches) to 70 mm (2.8 inches) in length.

wolf (gray/timber)

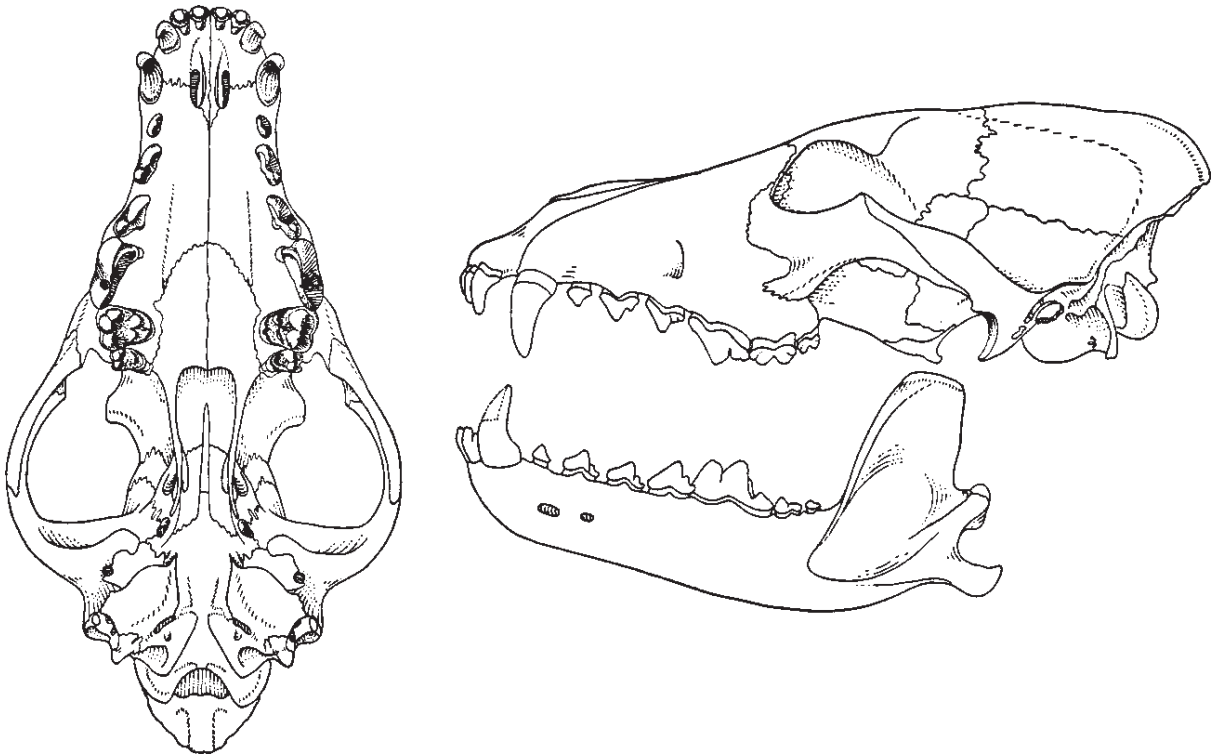
Order: CARNIVORA

Family: Canidae

Genus: Canis

species: lupus

dental formula: $I \frac{3}{3}, C \frac{1}{1}, P \frac{4}{4}, M \frac{2}{3} = 42$



The first obvious characteristic of all carnivore skulls is that the incisors are small compared to the enlarged canines.

The **wolf** skull differs from other carnivores of similar size, such as the bears, because the nose (rostrum) is long, narrow and more delicate.

The fourth upper tooth (fourth premolar) and the fifth lower tooth (first molar) are called carnassials

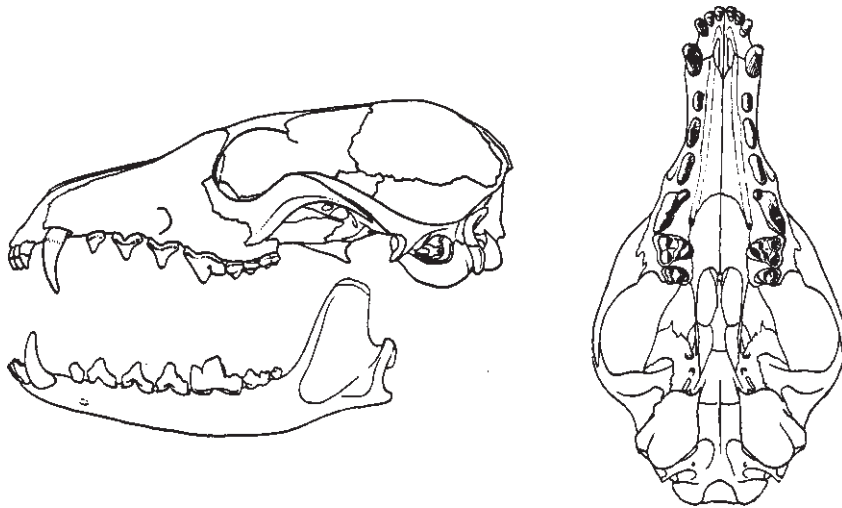
and are highly specialized for shearing meat and crushing bone. The skull has a pronounced sagittal crest.

The average adult wolf skull is 230 mm (9.1 inches) to 290 mm (11.4 inches) in length.

red fox

Order: CARNIVORA
Family: Canidae
Genus: Vulpes
species: vulpes

dental formula: $I \frac{3}{3}, C \frac{1}{1}, P \frac{4}{4}, M \frac{2}{3} = 42$



The **fox skull** has small incisors and larger canines, a characteristic of all carnivores. It is distinct from other non-canid carnivores because of the long and narrow nose (rostrum).

The skull is much smaller than the average wolf, averaging 105 mm (4.1 inches) to 122 mm (4.8 inches) in length, and has less of a sagittal crest on the top of its head.

It also has highly specialized carnassial teeth.

black bear

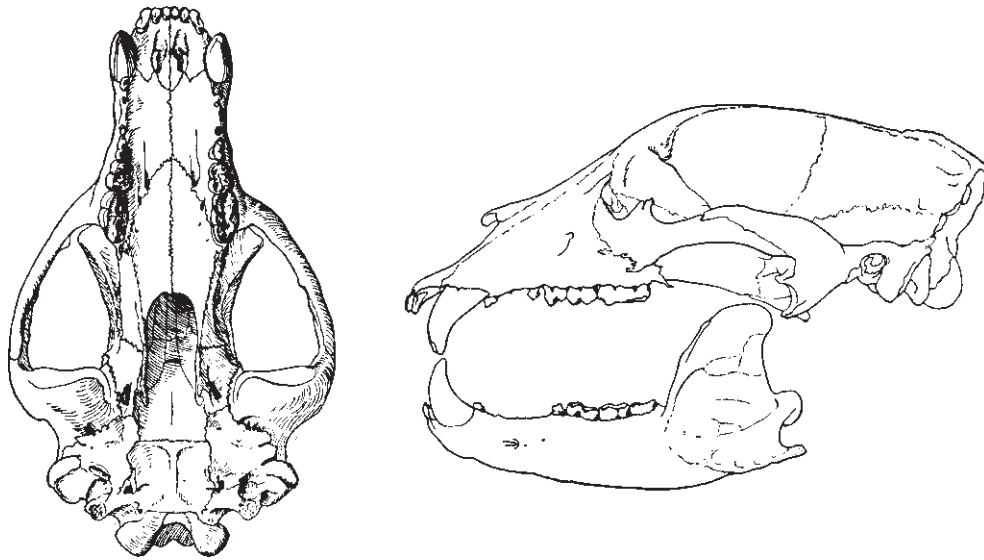
Order: CARNIVORA

Family: Ursidae

Genus: Ursus

species: americanus

dental formula: $I \frac{3}{3}, C \frac{1}{1}, P \frac{4}{4}, M \frac{2}{3} = 42$



The **black bear** skull, like the brown bear, has a broad and massive nose (rostrum).

The first three premolars are small or lost. The molars are squarish, broad and flat with four major cusps arranged in rectangles. This reflects their omnivorous food habits.

The last upper molar on an adult black bear is never more than 31 mm (1.25 inches), a distinguishing characteristic from brown bear skulls.

brown bear (grizzly)

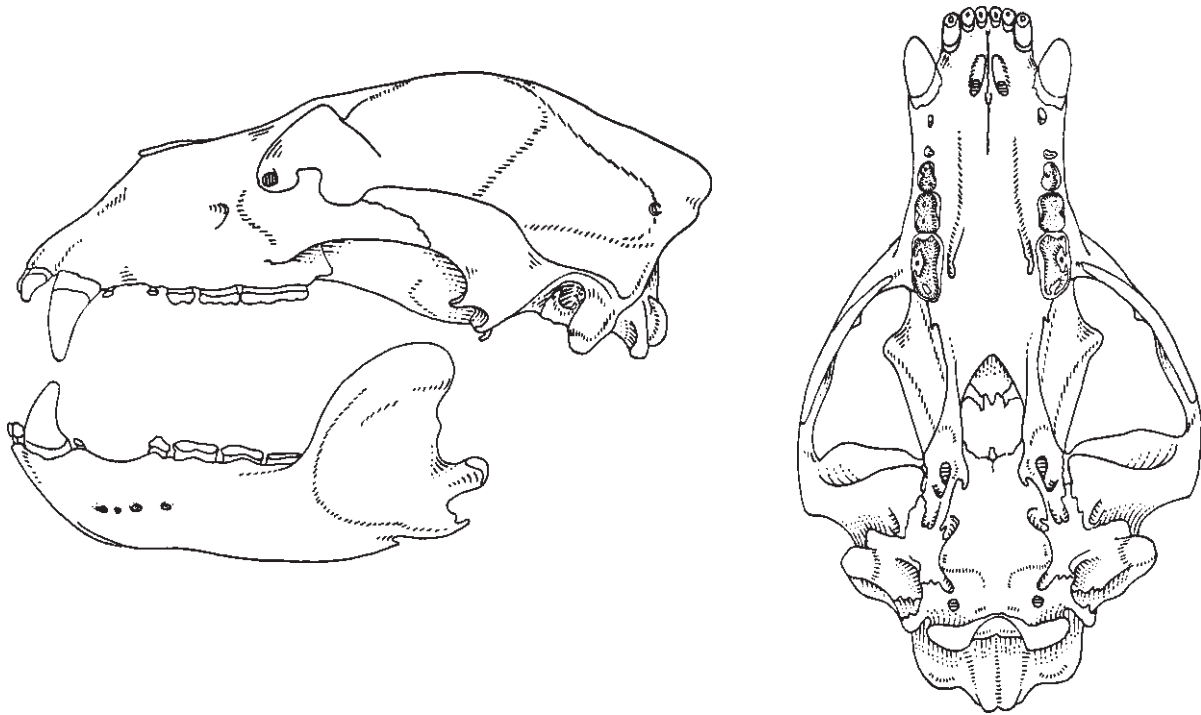
Order: CARNIVORA

Family: Ursidae

Genus: Ursus

species: arctos

dental formula: $I \frac{3}{3}, C \frac{1}{1}, P \frac{4}{4}, M \frac{2}{3} = 42$



The **brown bear**, **grizzly** and **Kodiak bear** are members of the same species. The primary distinction between these three bears is their geographical location.

The most obvious difference between brown bear and black bear skulls is their size; the brown bear's being larger.

The brown bear skull can also be distinguished from the black bear by looking at the last upper molar. On the brown bear it is usually 38 mm (1.5 inches) or greater in total length, while on the adult black bear it is usually not more than 31 mm (1.25 inches).

Other than size there is little difference between the lower jaw of the black and brown bear.

marten

Order: Carnivora

Family: Mustelidae

Genus: Martes

species: americana

dental formula: $I \frac{3}{3}, C \frac{1}{1}, P \frac{4}{4}, M \frac{1}{2} = 38$



The **marten** is a mid-sized mustelid. Its skull is approximately 80mm (3.25 inches) in length.

The rostrum of all mustelids is short and blunt, and the cranium (the portion of the skull behind the eye socket) is proportionately larger than the cranium of other animals.

The marten is distinct from other mustelids because of its size and because it has 38 teeth. In comparison mink are smaller and have only 34 teeth.

ermine (short-tailed weasel)

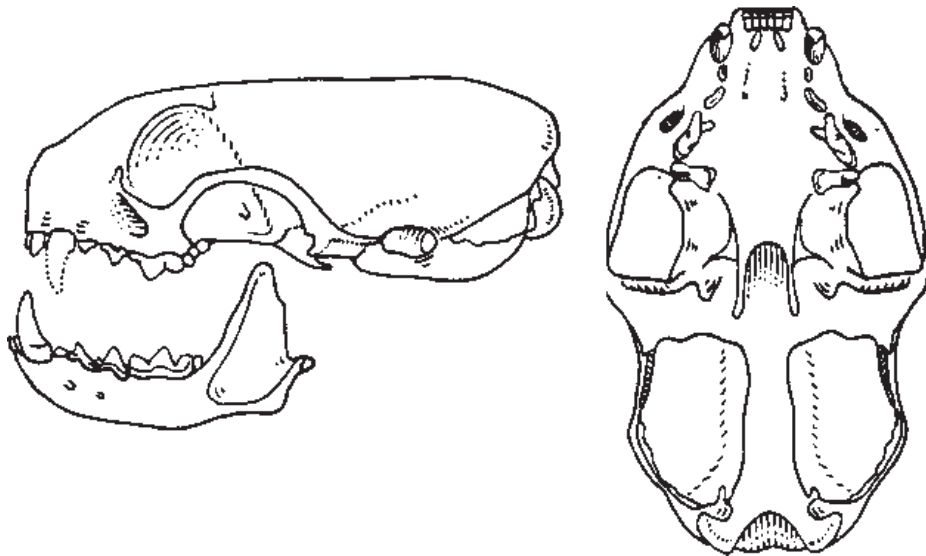
Order: Carnivora

Family: Mustelidae

Genus: Mustela

species: erminea

dental formula is: $I \frac{3}{3}, C \frac{1}{1}, P \frac{3}{3}, M \frac{1}{2} = 34$



The **short-tailed weasel** or **ermine**, like all mustelids, has a short and blunt nose (rostrum).

It has highly specialized carnassials for shearing meat.

Its skull is distinguishable from other mustelids by its small size; 50 mm (1.75 inches) in length.

mink

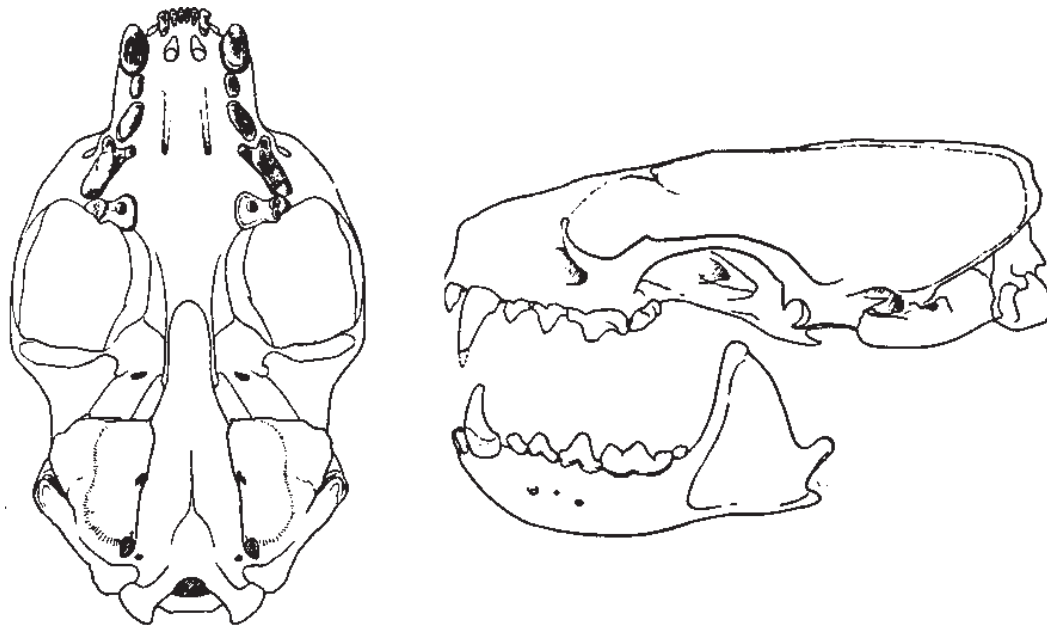
Order: Carnivora

Family: Mustelidae

Genus: Mustela

species: vison

dental formula is: $I \frac{3}{3}, C \frac{1}{1}, P \frac{3}{3}, M \frac{1}{2} = 34$



The **mink** skull is very similar to the marten skull but is much smaller in length; approximately 57 mm (or 2.5 inches) compared to approximately 80 mm (or 3.25 inches) for the marten.

Both mink and marten have teeth highly specialized for eating meat. They have long canines for stabbing prey animals, and premolars and molars adapted for shearing meat.

The main difference between these two mustelids, other than size, is that mink have 34 teeth and marten have 38.

lynx

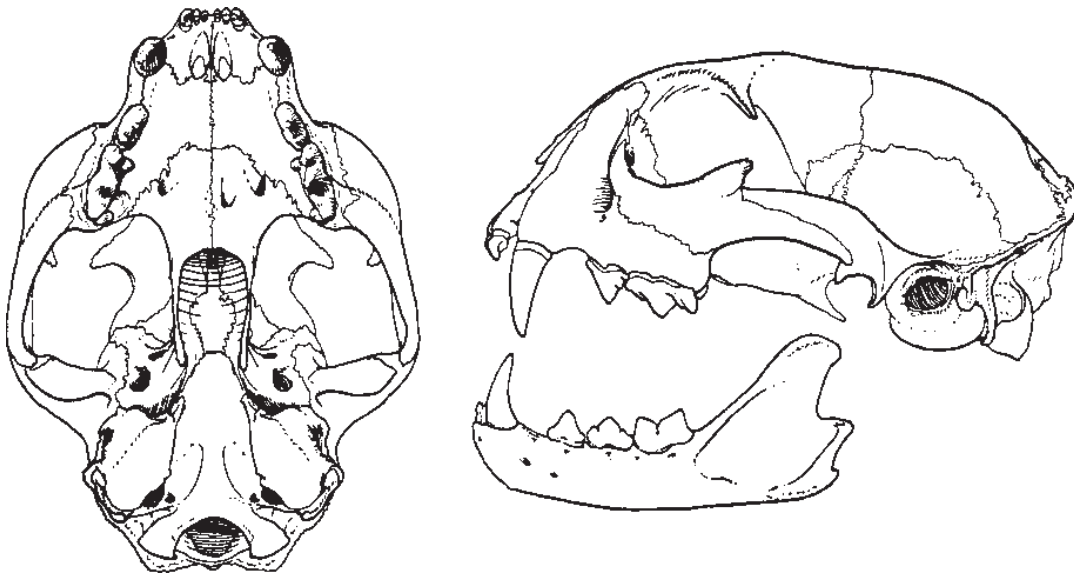
Order: Carnivora

Family: Felidae

Genus: Felis

species: lynx

dental formula is: $I \frac{3}{3}, C \frac{1}{1}, P \frac{2}{2}, M \frac{1}{1} = 28$



The most prominent feature of the **lynx** skull, which differentiates from all other carnivores, is the very short nose. Lynx possess fewer teeth than the other carnivores; just 28 teeth.

The other meat eaters have at least six molars (mink and marten) or as many as ten molars (wolf and fox). Lynx have only four molars.

All the cheek teeth are for shearing and are without grinding surfaces.

caribou

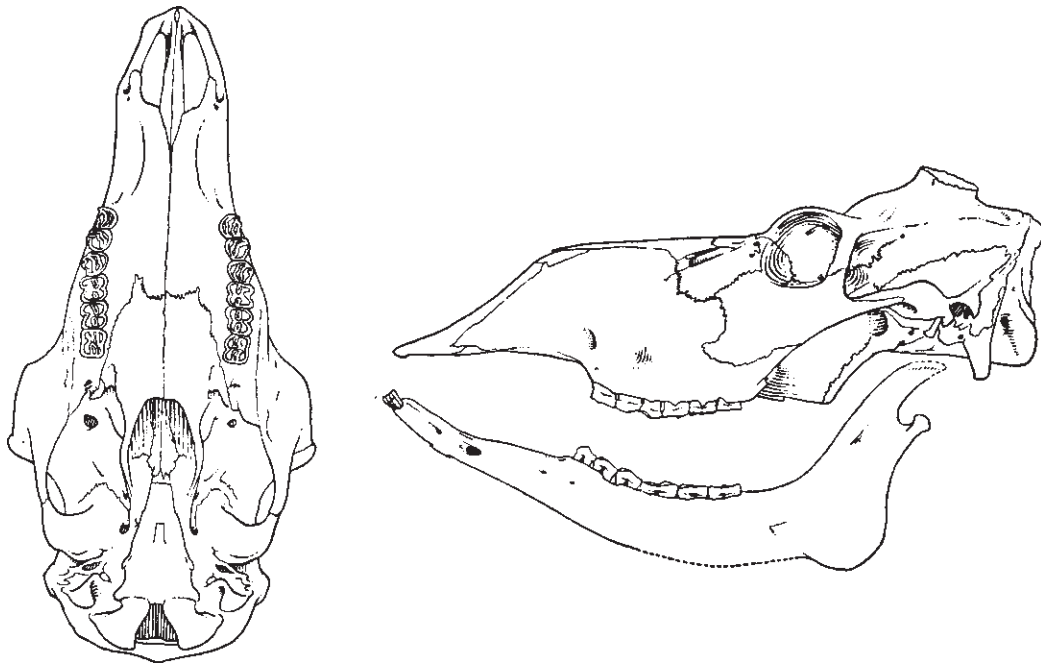
Order: Artiodactyla

Family: Cervidae

Genus: Rangifer

species: tarandus

dental formula is: $I \frac{0}{3}, C \frac{1}{1}, P \frac{3}{3}, M \frac{3}{3} = 34$



The **caribou** skull resembles the moose skull except that it is smaller; about 300 mm - 400 mm (11.8 to 15.8 inches) in length.

A caribou has 34 teeth and a moose has 32 teeth.

Another difference is that caribou have upper canines and moose do not, although the upper canines are not always obvious or present on a cleaned caribou skull.

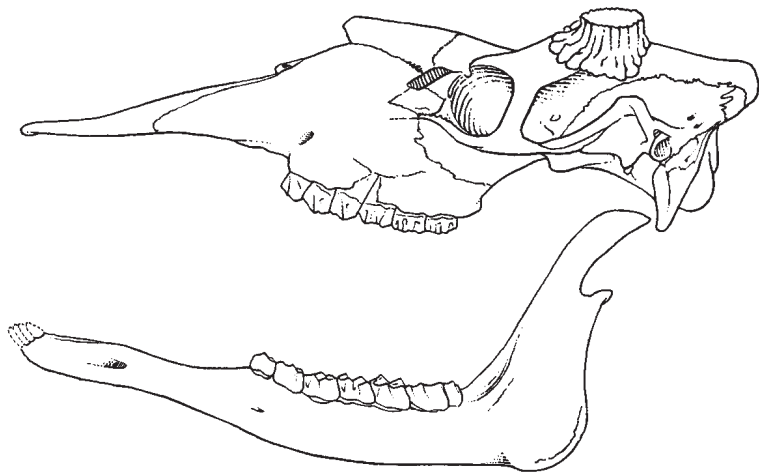
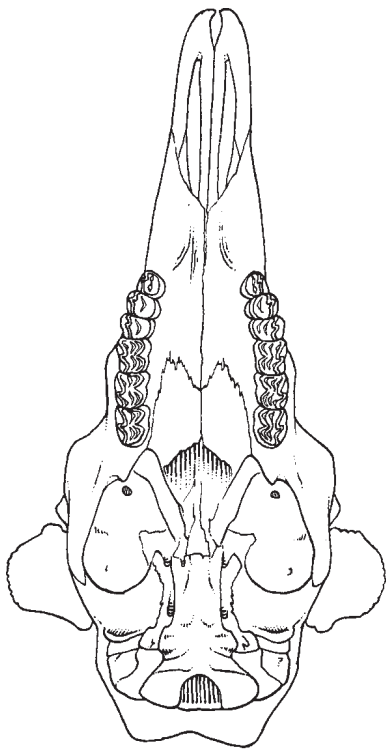
Both cows and bulls have antlers, which are shed each year).

The antlers are slightly palmated and asymmetrical, with one or more flattened tines (points on the antlers) extending down in front of the face. This feature is called the 'shovel.'

moose

Order: Artiodactyla
Family: Cervidae
Genus: Alces
species: alces

dental formula is: $I \frac{0}{3}, C \frac{0}{1}, P \frac{3}{3}, M \frac{3}{3} = 32$



The **moose** is the largest North American representative of the cervid family.

The elongated nose and the absence of upper incisors on the moose are characteristic of the Cervidae. In moose the upper canines are also absent.

The molars have vertical, crescent-shaped ridges of enamel.

The bull moose carries palmated antlers, which are shed in the late fall. Growth of new antlers begins again in March or April.

Female moose do not have antlers.

An adult moose skull may measure over 550 mm (25 inches) at greatest length.

Sitka black-tailed deer

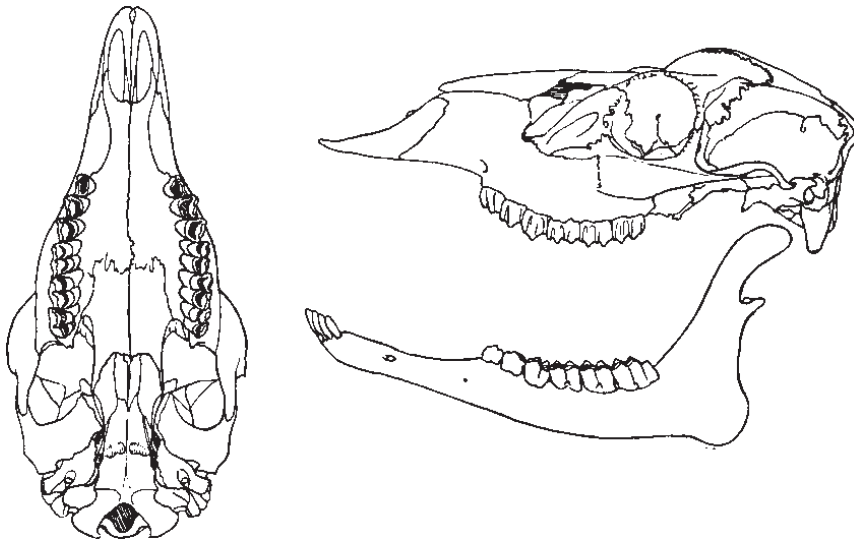
Order: Artiodactyla

Family: Cervidae

Genus: Odocoileus

species: hemionius

dental formula is: $I \frac{0}{3}, C \frac{0}{1}, P \frac{3}{3}, M \frac{3}{3} = 32$



Only the male **Sitka black-tailed deer** carries antlers, which are shed in late fall.

The (lacrimal) bone in front of eye socket is separated from the nasal bone by a wide space more than 10 mm, exposing the thin membranous bones lying underneath. This depression is deep enough to stick a finger in it.

mountain goat

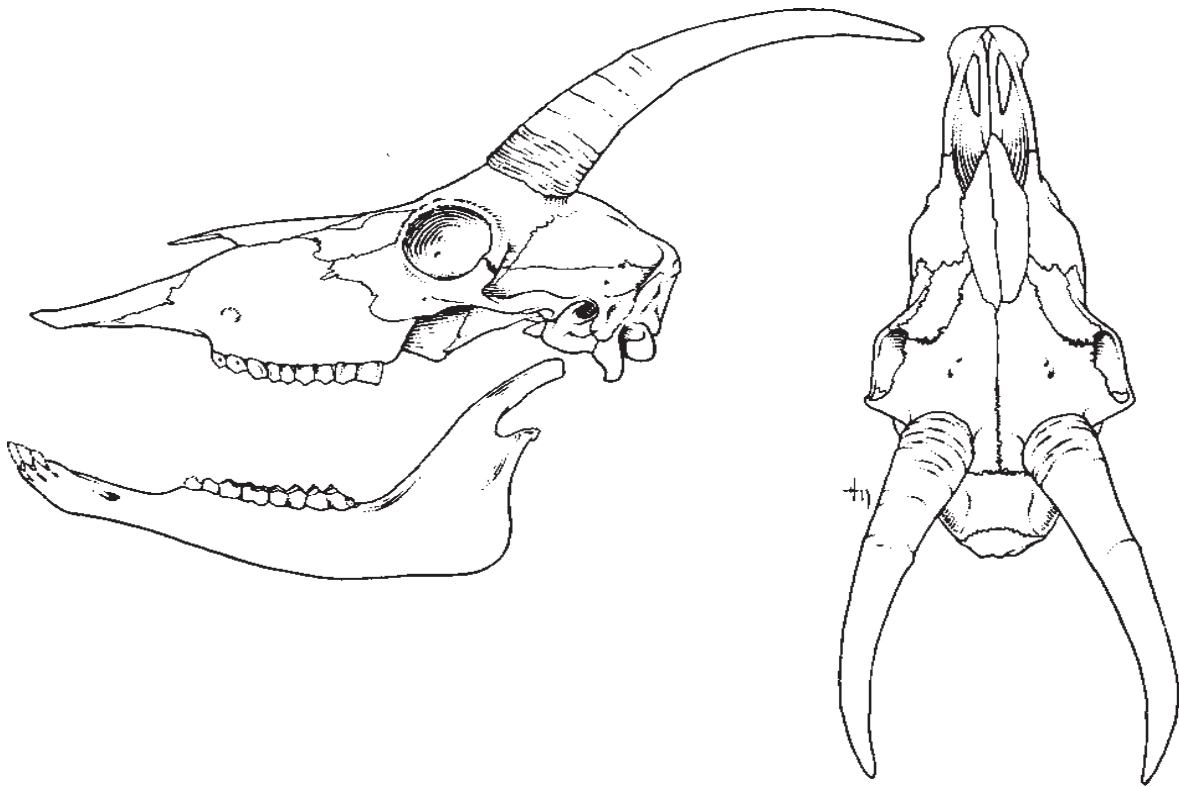
Order: Artiodactyla

Family: Bovidae

Genus: Oreamnos

species: americanus

dental formula is: $I \frac{0}{3}, C \frac{0}{1}, P \frac{3}{3}, M \frac{3}{3} = 32$



Both male and female mountain goat skulls have horns. The horn is composed of a bone core and covered with a keratin sheath, and is never shed.

The female horns are generally smaller in diameter than the male's, and are straighter than the male's. The space between horns in female is larger than the male, since the horn is smaller and takes up less space.

Another characteristic that distinguishes goat skulls (Family Bovidae) from deer and moose skulls (Family Cervidae) is the lack of a pit or depression in front of the orbits (eye sockets).

6. How to Clean a Skull

Every year thousands of people hunt and trap in Alaska. One of the small treasures discarded by many of these outdoor people is the skull of the hunted or trapped animal. A cleaned skull is a source of curiosity and wonder – a mirror of an animal's mode of life. Skulls provide insights into an animal's diet, strength of bite and its specially developed senses.

In addition to enjoying the natural wonder of skulls, a skull collection can be a great addition to a classroom in a variety of courses, including art, science and social studies. Cleaning a skull is an easy process and can be no more unpleasant than pulling meat off a cooked soup bone. Here is how to clean a skull for display or study.

Remove the hide

First, be sure to completely skin the hide off of the skull. The hide contains oils that permeate the bone when boiled and the result is a yellow, greasy skull. If the skull cannot be cleaned soon after the animal's death, freeze it. If the skull is malodorous from decay, it will be repugnant during boiling! In this situation, boil on a camp stove outside in a throw-away pot.

Boil the skull

Immerse the skull in water and let it boil. A thawed wolf or bear skull requires 2-3 hours of boiling. Smaller skulls, such as marten, fox or lynx, take about 40-60 minutes. Skulls from old animals often require longer boiling. Frozen skulls will take about 15-30 minutes longer. Boiling is completed when the muscle pulls off easily. Don't overcook it as the skull can fall apart if it is boiled or soaked for too long, especially if it is a young animal.

Caution: In dry climates boiling should be done at absolute minimum times to reduce excessive cracking of bone and teeth.

Save the teeth

Keep in mind that the teeth will likely fall out during boiling, and you'll need to strain them out of the bottom of the pot (and glue them back in later), so don't just dump out the water. You might consider boiling the skull in a paint strainer bag so as not to lose any of the teeth.

Remove meat & tissue

When cooked sufficiently, the muscle comes off in hunks. Remove the meat and brain tissue while they are still quite warm. Once cool and dry, thorough removal of tissue is more difficult. A thoroughly boiled skull can often be cleaned with water pressure alone, although you can also use a small knife (a scalpel works great if you have one) to gently scrape away

stubborn tissue. Take care not to cut or mar the bone! Nerve and connective tissue can be teased out of holes and crevices with a wire or large tweezers.

Clean out the brain

Next comes cleaning the inside the cranium (brain case). This is done through the oval opening at the back of the skull, where the skull attaches to the spine. On a bear or wolf, a small spoon is handy for scooping out the brain. Running a stiff wire or small knife around inside the skull, between the brain tissue and bone, helps loosen it and sometimes it will come out in large pieces. Water pressure can then be used to flush out the loosened pieces of brain material.

With smaller skulls, use a large tweezers to tease out brain tissue. Repeated rinsing flushes out loose tissue. There are scroll-like, delicate bones in the nasal cavities of animals. Try to keep them intact by working gently. If the skull was cooked long enough flushing water alternately through the brain and the nasal cavity should work out the residual tissue in these bones.

Soak the skull

After the skull is as clean as you can get it, soak it in an *enzyme-bleach powder* (such as Biz) using about $\frac{3}{4}$ cup to a gallon of water. **DO NOT USE LIQUID BLEACH** (such as Clorox)! It is harsher on the bone and does not have the enzyme action needed to break down residual tissue and grease. Leave big skulls (bear, wolf, caribou, bison) in this solution for 3 days. Smaller skulls may require less than 1 1/2 days.

The skull has soaked long enough when the remaining tissue can be easily removed. A small, stiff-bristled brush, a small knife or scalpel, and tweezers are adequate tools for doing the final clean up. Rinse the skull well after you have removed the last, stubborn tissues.

Caution: In dry climates soaking should be done at absolute minimum times to reduce excessive cracking of bone and teeth.

Whiten the skull

To whiten the skull (optional) soak it in 3% hydrogen peroxide for several days. Adding low heat will shorten this time. Be careful not to get hydrogen peroxide on your bare hands or in your eyes. Once the skull is white enough, rinse it *thoroughly* in clean water. Allow the skull to dry completely.

Repair & replace teeth

If the teeth have started to crack, fill the cracks with super glue to prevent further fracturing. When dry, use white glue to glue teeth back into their appropriate sockets. The teeth should fit fairly easily when matched with the exact hole it came from.

Coat the skull & teeth

Coat the entire skull and teeth with diluted clear-drying white glue and

allow to thoroughly dry. Then spray (or paint) the skull and teeth with two light coats and one final heavier coat of a clear varathane. Allow to dry between coats.

Once your final coat is dry, you're done!

When
acquiring
a skull...

There are a few important things to know when acquiring a skull.

Check the regulations. Skulls of animals taken during established hunting seasons within state and federal regulations are legal to possess. Some species are protected by state and federal laws and it is illegal to possess *any* parts of these animals. Examples are bald eagles, any birds protected by the migratory bird act, and marine mammals.

Skulls can't be sold. A hunter or trapper can *give* you a skull, but skulls cannot be sold, purchased or bartered.

Check the sealing requirements. The raw skulls of some species, such as wolves and bears, are required by law to have been 'sealed' by the Alaska Department of Fish and Game. A sealed skull has a colored band of plastic with a harvest number affixed to it. Once the skull is cleaned, the seal can be removed.

Don't kill animals just for skulls. This could be considered wanton waste, which is a misdemeanor.

Rabies is a concern In coastal Northwest Alaska. Use gloves, preferably disposable ones, when handling raw carnivore skulls from the western and northern coasts of Alaska. Cases of rabies have been reported from these areas, particularly in wolves and foxes. Once the skull has boiled for about 30 minutes the rabies virus will be destroyed.

Any questions or concerns? When in doubt about possession or legality of a skull, contact the Alaska Department of Fish and Game, or the Alaska Bureau of Wildlife Enforcement in your area.



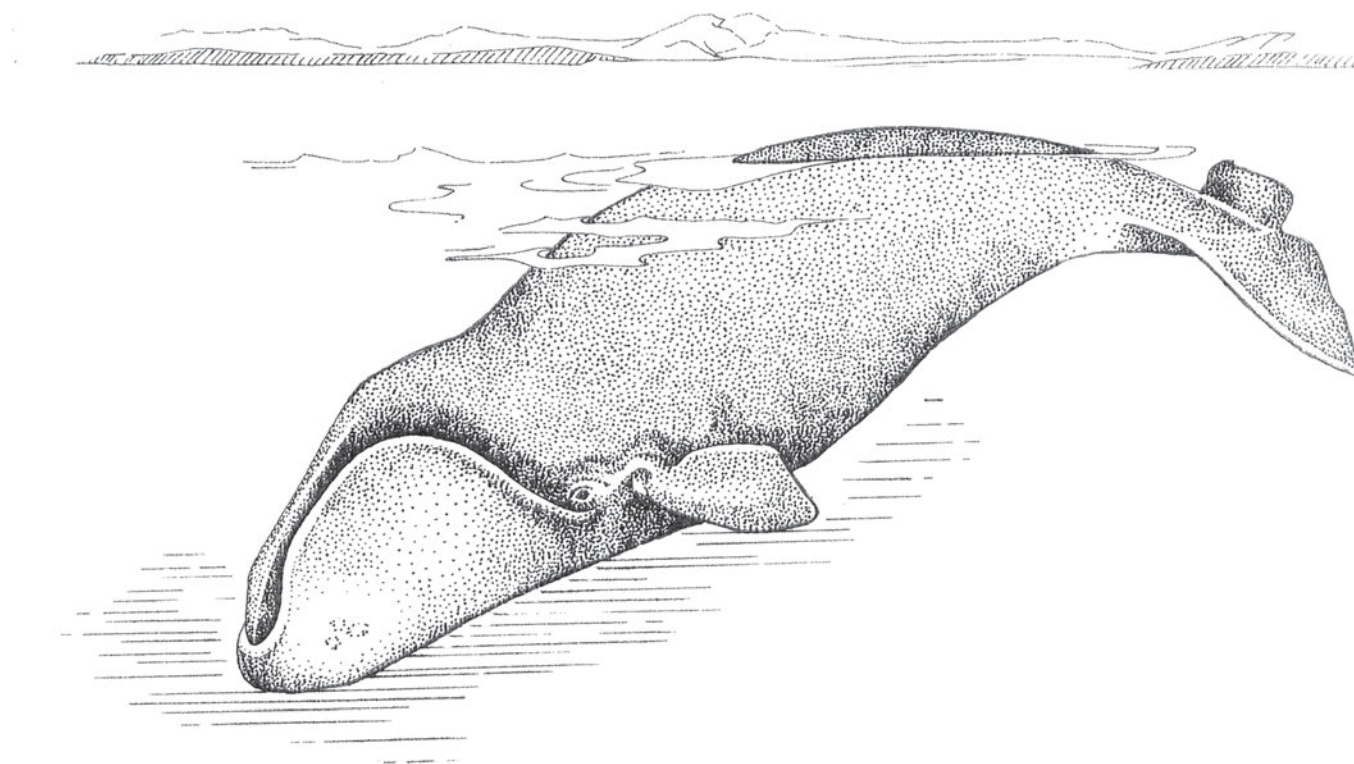
7. Glossary of terms



anatomy:	The structure of an animal or parts of an animal.
Artiodactyla	An order of the hoofed mammals which have an even number of toes; this order includes deer, cows, sheep, goats, moose and caribou.
auditory bullae	The bulbous bony structures that encase the inner ear.
binocular vision	The type of vision in which both eyes focus on a single object at the same time, forming one three-dimensional image.
Canidae	The dog family; includes fox, coyote, and wolf.
canine	The large, pointed tooth of a carnivore or the incisor-like, fourth tooth of a herbivore.
carnassial teeth	A large pair of bladelike teeth that come together with a scissor action.
carnivora	The order of mammals that are primarily meat eaters.
carnivore	An animal that predominantly eats meat.
Castoridae	The beaver family; beaver is only member of this family.
Cervidae	The deer family; includes moose and caribou.
cheek teeth	A collective name for premolars and molars.
class	A sub-grouping of animals; class Mammalia includes all mammals.
coronoid process	The place on the lower jaw where the the cheek (temporal) muscles attach.
cranium	The part of the skull that encloses the brain..
Cricetidae	A mouse family; includes voles, lemmings, and muskrat.
dentition	The number, kind, and arrangement of teeth in upper and lower jaws.
dentine	The soft material in a tooth; usually, but not always covered by enamel.
deciduous teeth	The first set of teeth (baby teeth) which are shed and replaced by adult teeth.
enamel	The hard covering of exposed part of tooth.
evolution(ary)	A gradual process over time during which an organism changes form.
Family	A grouping of similar organisms ranking below an order and above a genus.
Felidae	The cat family; includes lynx.
foramen magnum	The largest hole in a skull through which the spinal cord passes.
foramina	The holes in a skull that provide passage for nerves and blood vessels.

furbearer	An animal that is valued for its fur. A lynx is a furbearer but a moose is not.
game animal	An animal harvested usually for meat but sometimes for its hide, too.
genus	A grouping of similar organisms ranking below a family and above a species; it is the first part of the animal's scientific name. For example, <i>Lepus</i> is the genus of <i>Lepus americanus</i> , the snowshoe hare. Genus and species are underlined or italicised in scientific writing.
herbivore	An animal that eats plants.
incisor	A chisel-shaped tooth adapted for cutting located in the front of the mouth. Most animals have three on each side of the upper and lower jaw.
Lagomorpha	The order which includes hares, pikas, and rabbits.
mammal	Belonging to the class Mammalia; distinguished by self-regulating body temperature, hair, and in females, milk production for feeding young; includes hare, beaver, moose, wolf, bear and humans.
mandible	The lower jaw.
mandibular condyle	The small process on the end of the mandible that fits into a groove in the skull to form the jaw joint.
molars	The teeth in the back of the mouth; these teeth and the premolars collectively are called cheek teeth. Molars have no deciduous (milk teeth) predecessors.
Mustelidae	The ermine family; includes mink, marten and wolverine.
omnivore	An animal that eats both plants and animals.
orbit	The cavity in the skull which houses the eyeball.
order	A grouping of closely related organisms ranking below the class and above the family categories.
phylogeny	The historical (evolutionary) development of a species of animal (or plant).
predator	An animal that kills and eats other animals.
premolars	The teeth preceding the molars. These and the molars collectively are called cheek teeth. Unlike molars, these are deciduous predecessors to premolars.
prey	The animals killed and eaten by predators.
Rodentia	The order which includes mice, voles, squirrels, muskrat, and beaver.
rostrum	The nose, snout.
sagittal crest	A raised ridge on top of the braincase; most prominent in wolves and wolverine.
species	The smallest unit of classification. The ' <u>americanus</u> ' in <u><i>Lepus americanus</i></u> (snowshoe hare) is the species name.
taxonomist	One who studies the classification of living things.
tooth type	For the purposes of this guide, tooth type refers to whether the surfaces of the teeth are flat or sharp, and if they are used for shearing, tearing or grinding.

Ursidae	The bear family; includes black, brown and polar bears.
vestigial (teeth)	Teeth that have become reduced in size through reduced use over evolutionary time.
zygomatic arch:	The cheek bone; the arched bone that extends from below the orbit to the back of the skull.



8. Teacher Resources



Web sites

ADF&G www.wildlife.alaska.gov

The Alaska Department of Fish & Game offers a host of online materials about Alaska's wildlife, including:

- Alaska Wildlife Notebook Series
- Teacher Resources Page
- Endangered species in Alaska
- 'Sounds Wild' audio pieces
- Funtastic Facts

UAF www.uaf.edu/museum/mammal/AK_Mammals/Checklist.html

A complete list of Alaska's mammals from the University of Alaska, Fairbanks Museum

ANHA www.alaskanha.org

The Alaska Natural History Association offers information about wildlife on public lands, natural history seminars and teacher trainings, and an online bookstore stocked with wildlife and natural history related materials.

Books

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Weichert, C. K. *Anatomy of the Chordates*. McGraw-Hill Book Co., New York, 1970.

A few last requests...

A caution about copyright

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Cultural considerations

When teaching about Alaskan mammals, it is important to note that there are some cultural mores where it is inappropriate to talk about a particular species. For example, the Athabascan culture traditionally discourages women from speaking about bears. We encourage you to check with folks in your local community about traditional knowledge ahead of time.

Community involvement

Lessons about Alaskan mammals lend themselves well to community involvement. Invite community members, such as Elders, trappers, hunters and biologists, who are knowledgeable about wildlife to visit with your students.

Our thanks!

We hope you enjoy teaching about Alaskan mammals. We thank you for your respectful use of this teaching resource.

